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Please direct correspondence to:

David W. Kohlhorst or James J. Orsi
Co-Editors-in-Chief
California Fish and Game
4001 North Wilson Way
Stockton, California 95205-2486
e-mail: dkohlhor@delta.dfg.ca.gov
jorsi@delta.dfg.ca.gov

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A Bibliography of Feral, Stray, and Free-roaming Domestic Cats in Relation to Wildlife Conservation. 1994. Ronald M. Jurek. California Department of Fish and Game, Nongame Bird and Mammal Program Report No. 94-5. 24 pages. This is a comprehensive bibliography of 340 international references, mostly concerning effects of the domestic cat, *Felis catus*, on wildlife resource management and protection. The bibliography includes a subject index to aid the reader in identifying content of cited articles. The purpose of this bibliography is to provide an information source on the ecology and control of feral and free-roaming domestic cats and their damaging effects on wildlife. It is available free of charge from the author, c/o Bird and Mammal Conservation Program, California Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814-5509.

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AN ANALYSIS OF COMMERCIAL PASSENGER FISHING VESSEL FISHERIES FOR KELP BASS AND BARRED SAND BASS IN THE SOUTHERN CALIFORNIA BIGHT

MILTON S. LOVE and ANDREW BROOKS
Marine Science Institute
University of California
Santa Barbara, California 93106

J. R. RAYMOND ALLY
California Department of Fish and Game
330 Golden Shore, Suite 50
Long Beach, California 90802

We describe the sport fishery for kelp bass, *Paralabrax clathratus*, and barred sand bass, *P. nebulifer*, in the Southern California Bight using catch data from two commercial passenger fishing vessel (CPFV) creel censuses conducted from 1975 to 1978 and 1986 to 1989. In the 1986-1989 census, both species ranked in the top three as measured by catch per unit effort (CPUE). Catch per unit effort of both species was much higher during 1986-1989 than in 1975-1978. The increased catches in the 1980s were likely due to increased abundance, rather than changes in targeting by vessel operators. Sites with highest CPUE for kelp bass contained high relief, both with and without kelp. The highest CPUE occurred at several oil platforms offSanta Barbara. Most of the best fishing sites were located in the northern part of the Southern California Bight, probably because fishing pressure is lower there than to the south. Kelp bass fishing was best in late spring and early fall; catches decreased during the peak of the spawning period. Highest catches of barred sand bass occurred over low relief or sandy bottoms where spawning aggregations occurred. Catch per unit effort was highest during the summer spawning period. Kelp bass were most commonly taken from <30 m. Barred sand bass were most abundant in10-50 m. Mean lengths of both species taken in the CPFV fishery were essentially unchanged between the 1970s and 1980s; during both periods the majority of the fishes caught were above the legal size limit of 30.5 cm total length.

INTRODUCTION

Kelp bass, *Paralabrax clathratus*, and barred sand bass, *P. nebulifer*, are two very abundant near-shore species in the Southern California Bight. Excluded by law from the California commercial fishery since 1953, these two sport fishes are among the three most important species in the commercial passenger fishing vessel (CPFV)

catch (Ally et al.[1] 1991) and in the top six in private boat landings (Wine[2] 1979). Commercial passenger fishing vessels may take >1 million kelp bass and >600,000 barred sand bass annually (Ally et al.[1] 1991).

Kelp bass are popular because they strike hard, are relatively easy to hook, are often taken near the surface, and are palatable. Additionally, because kelp bass tend to be found around fouling areas (kelp beds, oil platforms, and high-relief reefs), there is a degree of difficulty landing them, though they are not as difficult to boat as larger species, such as yellowtail, *Seriola lalandi*. Many fishing clubs in southern California charter CPFVs specifically to catch kelp bass. Several CPFV operators note that on slow kelp bass days, many passengers would rather continue fishing for that species than switch to more readily available species, such as the various shallow water rockfishes (*Scorpaenidae*).

Barred sand bass are also popular and sought after by CPFV anglers. Most sand bass are taken during summer, when they aggregate at specific, predictable sites to spawn. During these times, hundreds of fish may be taken per vessel. In general, this bottom-dwelling species requires less skill to hook and land than kelp bass and the fish is held in slightly lower esteem than kelp bass by many anglers. Operators often seek out barred sand bass when their passengers include large numbers of relatively inexperienced fishermen.

Despite considerable previous research, little has been published on the sport fishery for barred sand bass. The kelp bass fishery has not been studied since the 1950s (Young 1963). This paper summarizes a series of studies that fill in gaps in our knowledge.

METHODS

Fishes taken aboard CPFVs were sampled by the senior author and by California Department of Fish and Game (CDFG) personnel from 1975 to 1978 and by CDFG personnel from 1986 to 1989. We randomly sampled regularly scheduled trips by vessels operating from Point Conception to the Mexican border. In the 1970s, 2,234 trips were surveyed and 342,051 fishes identified; in the 1980s, 4,938 trips were sampled and 437,028 fishes identified.

The sampler boarded the vessel at the beginning of the trip and remained aboard to identify; count; and, if possible, measure all fishes caught by passengers. Particular effort was made to count and measure all fishes released. The sampler also noted date, whether the boat fished in Mexican waters, number of anglers (including

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[1] Ally, J.R.R., D.S. Ono, R.B. Read, and M. Wallace. 1991. Status of major southern California marine sport fish species with management recommendations, based on analyses of catch and size composition data collected on board commercial passenger fishing vessels from 1985 through 1987. California Department of Fish and Game, Marine Resources Administrative Report No. 90-2.

[2] Wine, V. 1979. Southern California independent sport fishing survey, annual report no. 3. California Department of Fish and Game, Marine Resources Administrative Report No. 79-3.

crew, if they fished), time fished in each location, and bottom depth.

Each fish was measured to the nearest millimeter. When fishes were brought aboard too rapidly for all to be measured or identified, samplers gave priority to those being returned to the water and measured or identified the remaining fishes at the end of the day.

We estimated relative fish abundances using catch per unit effort (CPUE), defined as number of fish taken per angler-h (where angler-h = number of anglers x number of hours fished). To rank species within each year, we calculated an annual CPUE by dividing total number of fish caught (by species) by total effort during the year. We characterized each fishing site in terms of overall CPUE for kelp bass and barred sand bass by grouping all years in each of the two time periods (1975-1978 and 1986-1989) and dividing the species' total catch at each site by the effort at that site.

During the year (or annually), CPFV operators may shift their emphasis among a variety of species. For instance, while deeper-water rockfishes are targeted during winter, the same vessels may shift to kelp bass in spring and barred sand bass in summer. Also, estimates of seasonal changes in CPUE (and relative abundance) of kelp bass and barred sand bass may be biased by shifts in fishing effort from reefs inhibited by these species to reefs where they are absent. Thus, for our analysis of seasonal changes in CPUE, we included data only from sites that were fished during all seasons and where kelp bass or barred sand bass were taken during at least one season. To compare the CPUE of each species between years, we used only those reefs on which the species occurred during at least 1 of the 8 years. All comparisons were made using standard analysis of variance with individual trips counted as separate observations for calculation of mean CPUEs. Multiple comparison tests were made using the Ryan-Einot-Gabriel-Welsch Multiple F-test (REGWF option, Proc GLM, SAS 1987).

Standard statistical methods were used for other comparisons. We used an approximate t-test, assuming unequal variances, to compare mean lengths between periods. Chi-square was used to compare length-frequency distributions.

RESULTS AND DISCUSSION

Annual Catch Per Unit Effort

Kelp bass were an important recreational species in the 1975-1978 survey, consistently ranking third in CPUE; barred sand bass were less important, ranking between fifth and tenth (Table 1). Catches of both species, but particularly barred sand bass, were relatively low. The maximum CPUE of kelp bass was 0.26; that of barred sand bass, 0.07.

In 1986-1989, kelp bass and barred sand bass were consistently among the top three species in the CPFV catch (Table 2). Kelp bass were particularly important, ranking either first or second in all 4 years. During the same period, barred sand bass ranged from first to third.

Catch rates of both species were higher during 1986-1989 than in 1975-1978

Table 1. Top ten species in the southern California commercial passenger fishing vessel catch from 1975-1978 as measured by the number of fishes taken per angler-h (in parentheses).

1975		1976	
1. Boccacio, *Sebastes paucispinis*	(0.42)	1. Boccacio	(0.41)
2. Pacific Bonito, *Sarda chiliensis*	(0.08)	2. Chilipepper	(0.14)
3. Kelp Bass, *Paralabrax clathratus*	(0.07)	3. Kelp Bass	(0.13)
4. Chilipepper, *S. goodei*	(0.06)	4. Olive Rockfish	(0.07)
5. Olive Rockfish, *S. serranoides*	(0.06)	5. Barred Sand Bass	(0.06)
6. Blue Rockfish, *S. mystinus*	(0.04)	6. Pacific Bonito	(0.06)
7. Chub Mackerel, *Scomber japonicus*	(0.03)	7. Pacific Barracuda	(0.04)
8. Sablefish, *Anoplopoma fimbria*	(0.03)	8. Blue Rockfish	(0.03)
9. Pacific Barracuda, *Sphyraena argentea*	(0.03)	9. Ocean Whitefish, *Caulolatilus princeps*	(0.02)
10. Barred Sand Bass, *Paralabrax nebulifer*	(0.03)	10. Vermilion Rockfish, *Sebastes miniatus*	(0.02)
1977		**1978**	
1. Chub Mackerel	(0.21)	1. Chub Mackerel	(0.21)
2. Boccacio	(0.20)	2. Boccacio	(0.29)
3. Kelp Bass	(0.17)	3. Kelp Bass	(0.26)
4. Olive Rockfish	(0.13)	4. Chilipepper	(0.13)
5. Chilipepper	(0.11)	5. Pacific Bonito	(0.08)
6. Blue Rockfish	(0.09)	6. Blue Rockfish	(0.06)
7. Barred Sand Bass	(0.07)	7. Olive Rockfish	(0.06)
8. Pacific Bonito	(0.05)	8. Barred Sand Bass	(0.06)
9. Pacific Barracuda	(0.04)	9. White Croaker, *Genyonemus lineatus*	(0.06)
10. Halfmoon, *Medialuna californiensis*	(0.04)	10. Pacific Barracuda	(0.03)

(Table 2). This pattern was particularly evident for barred sand bass, where the 1980s CPUE was 5-10 times that of the 1970s. Because kelp bass and barred sand bass are very popular recreational species (actively sought by CPFV operators), and have been for many decades (Frey 1971), we believe low CPUEs in the previous period were due to depressed abundances of these fishes, rather than operators targeting other species.

Kelp bass CPUE differed significantly among years ($F=25.85, P<0.001$). Catch per unit effort was significantly and consistently higher beginning in 1978 (Fig. 1). A similar pattern held for barred sand bass ($F = 14.84, P < 0.001$) (Fig. 1). Again, CPUE in the 1980s was significantly higher than in the 1970s. It is possible that populations of both kelp bass and barred sand bass benefited from rising ocean temperatures in the mid-1970s and increased recruitment success (Stephens et al. 1994).

Table 2. Top ten species in the southern California commercial passenger fishing vessel catch from 1986-89 as measured by the number of fishes taken per angler-h (in parentheses).

1986		1987	
1. Kelp Bass	(0.44)	1. Chub Mackerel	(0.40)
2. Chub Mackerel	(0.34)	2. Kelp Bass	(0.34)
3. Barred Sand Bass	(0.19)	3. Barred Sand Bass	(0.34)
4. Pacific Bonito	(0.18)	4. Pacific Bonito	(0.21)
5. Pacific Barracuda	(0.13)	5. Pacific Barracuda	(0.16)
6. Boccacio	(0.07)	6. Chilipepper	(0.08)
7. Ocean Whitefish	(0.04)	7. Boccacio	(0.05)
8. White Croaker	(0.04)	8. California Scorpionfish	(0.04)
9. Chilipepper	(0.03)	9. Vermilion Rockfish	(0.04)
10. California Scorpionfish, *Scorpaena guttata*	(0.03)	10. Ocean Whitefish	(0.03)

1988		1989	
1. Barred Sand Bass	(0.33)	1. Kelp Bass	(0.32)
2. Kelp Bass	(0.28)	2. Chub Mackerel	(0.27)
3. Chub Mackerel	(0.22)	3. Barred Sand Bass	(0.27)
4. Pacific Barracuda	(0.12)	4. Pacific Bonito	(0.16)
5. California Scorpionfish	(0.10)	5. Pacific Barracuda	(0.11)
6. Pacific Bonito	(0.09)	6. California Scorpionfish	(0.10)
7. Chilipepper	(0.06)	7. Boccacio	(0.10)
8. Vermilion Rockfish	(0.06)	8. Chilipepper	(0.08)
9. White Croaker	(0.04)	9. White Croaker	(0.04)
10. Boccacio	(0.04)	10. Vermilion Rockfish	(0.04)

The increased year-class strength of both species in the late 1970s is also reflected in the changes in the proportion of legal-sized fishes (>30.5 cm total length) taken by CPFVs (Fig. 2). The proportion of legal-sized kelp bass was higher in 1975-76 than in 1977-78. The proportion of legal-sized sand barred bass remained high through 1977, then decreased slightly in 1978. We believe these shifts in size composition of the catch were due to increased numbers of small bass throughout the Southern California Bight (Stephens et al. 1994), reflecting substantial recruitment of kelp bass in the late 1970s, and the lesser success of barred sand bass during the same period, rather than a decrease in the number of larger fish due to fishing.

Geographic Distribution

Several productive kelp bass fishing sites exist in the Southern California Bight. Kelp bass tend to be found over high-relief, often kelp-covered, substrates. Areas off rocky headlands, such as Palos Verdes and Point Dume, seem particularly favorable. Excluding sites with low (<100 angler-h) effort, 22 sites had CPUEs >1.0 kelp bass per angler-h (Fig. 3, Table 3). While all these sites contained high relief, some were natural formations and some were artificial. Kelp was present on most, but not all, of the most important sites.

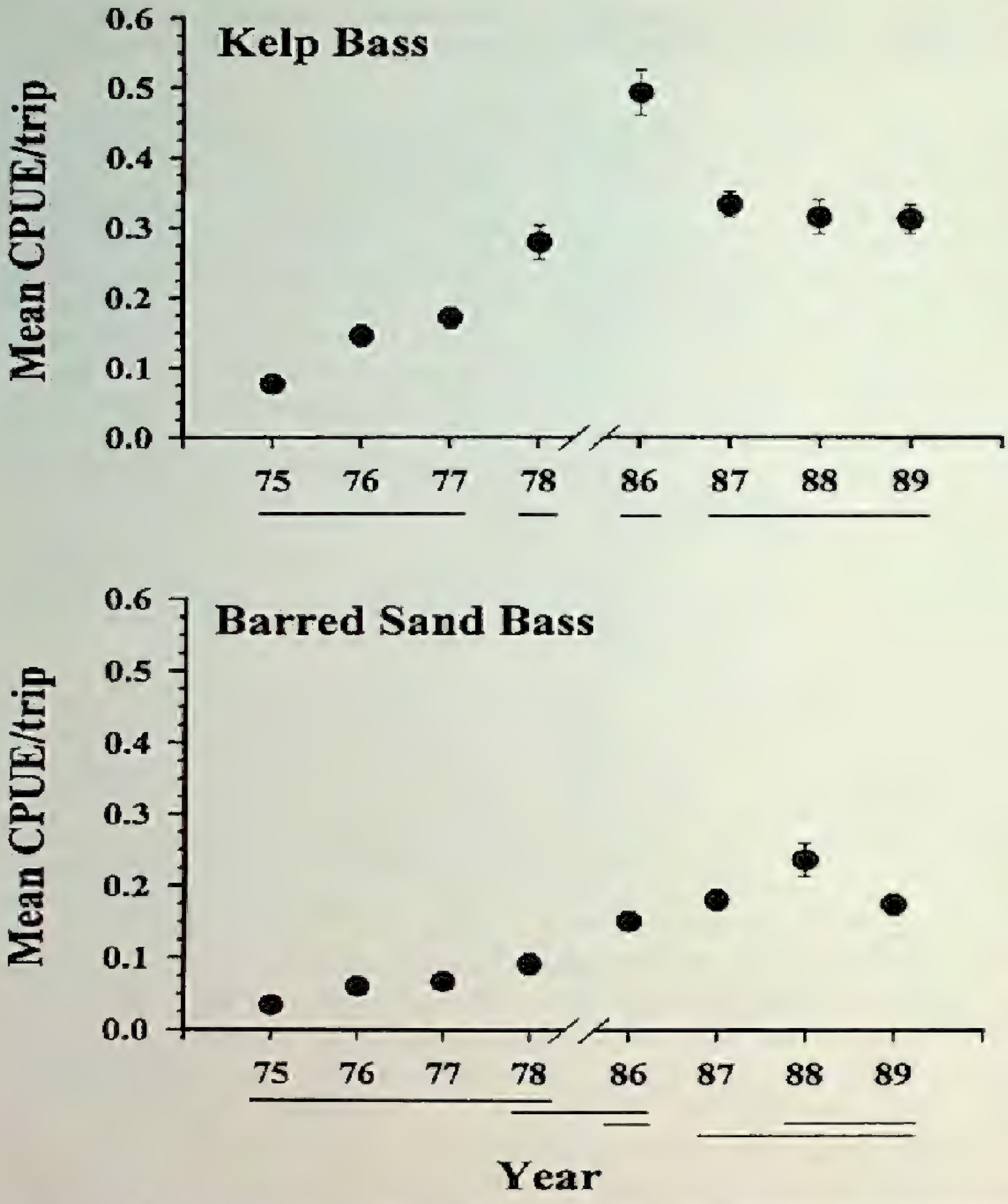

Figure 1. Annual mean catch per angler-h of kelp bass and barred sand bass taken in the southern California commercial passenger fishing vessel fishery, 1975-1978 and 1986-1989. Horizontal lines below the abcissa indicate statistically significant groupings using the Ryan-Einot-Gabriel-Welsch Multiple F-test. Error bars are +/- one standard error about the mean.

With the exception of one site (Cardiff-By-The-Sea, about 40 km north of San Diego), all of the most productive kelp bass sites were either along the mainland in the northernmost part of the Southern California Bight or around the Channel Islands. Of the 22 sites, 11 were mainland ones within 30 km of Santa Barbara. Including the northern Channel Island locations with the mainland sites, 17 of 22 sites are in this region. The highest CPUE of any of these areas was 2.4 kelp bass per

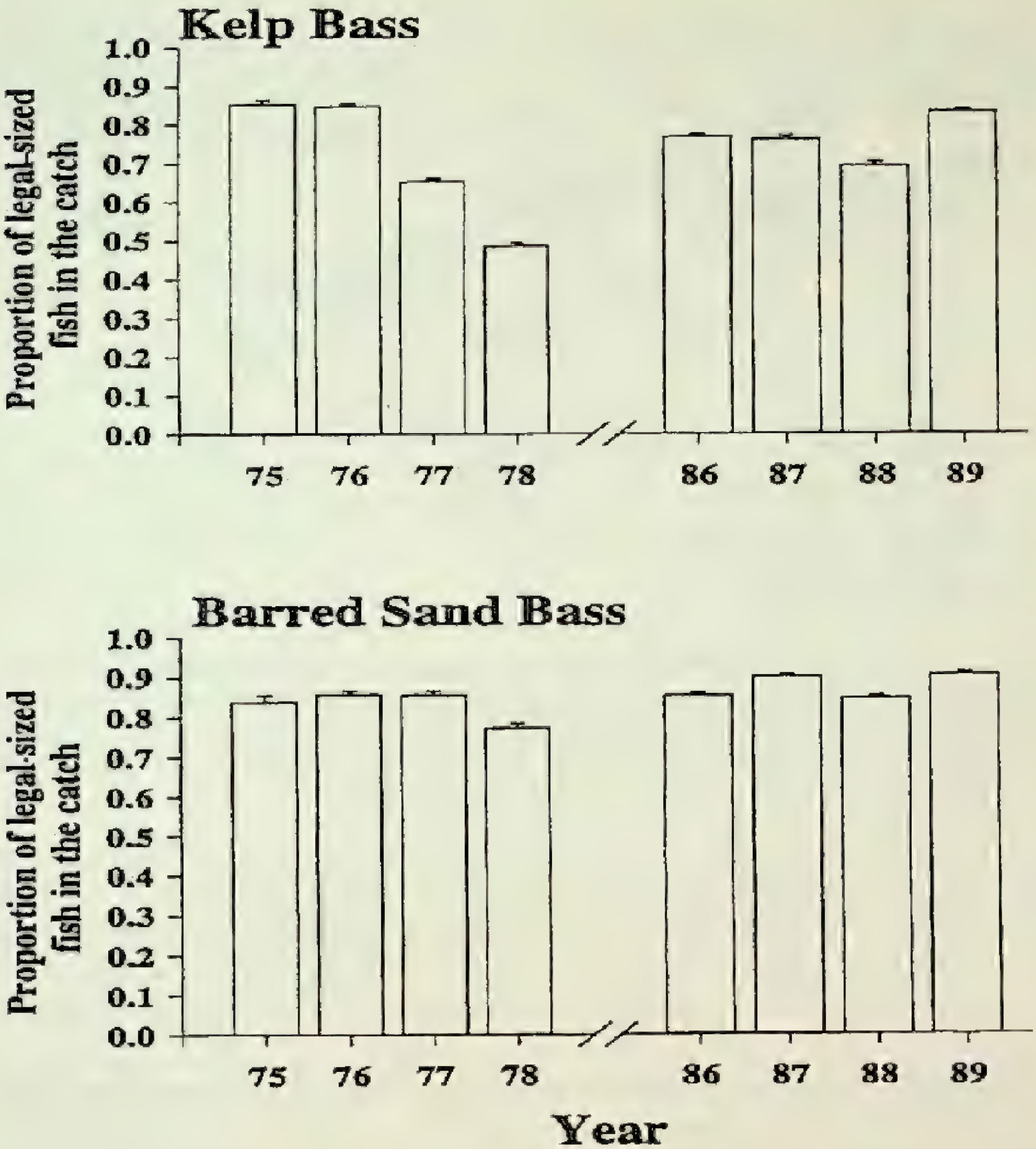

Figure 2. The proportion of legal-sized (>30.5 cm) kelp bass and barred sand bass taken in the southern California commercial passenger fishing vessel sport fishery, 1975-1978 and 1986-1989. Error bars represent 95% confidence limits calculated as in Rohlf and Sokal (1981).

angler-h at the adjoining oil platforms Hilda and Hazel (data from these platforms were pooled) situated in about 30 m of water, 3.5 km offshore of Summerland, 10 km east of Santa Barbara. Kelp does not grow on these platforms, nor adjacent to them. In contrast, the next highest CPUE, 2.3 kelp bass per angler-h, was obtained at Naples Reef, a high-relief natural formation (usually kelp covered) located at a depth of 8-12 m, 1.6 km offshore of Naples, 24 km west of Santa Barbara.

This pattern in CPUE suggests that fishing success is inversely related to fishing effort. The northern part of the bight (from Ventura north) is lightly fished when compared to areas from Los Angeles south (Fig. 4). This southern area is more

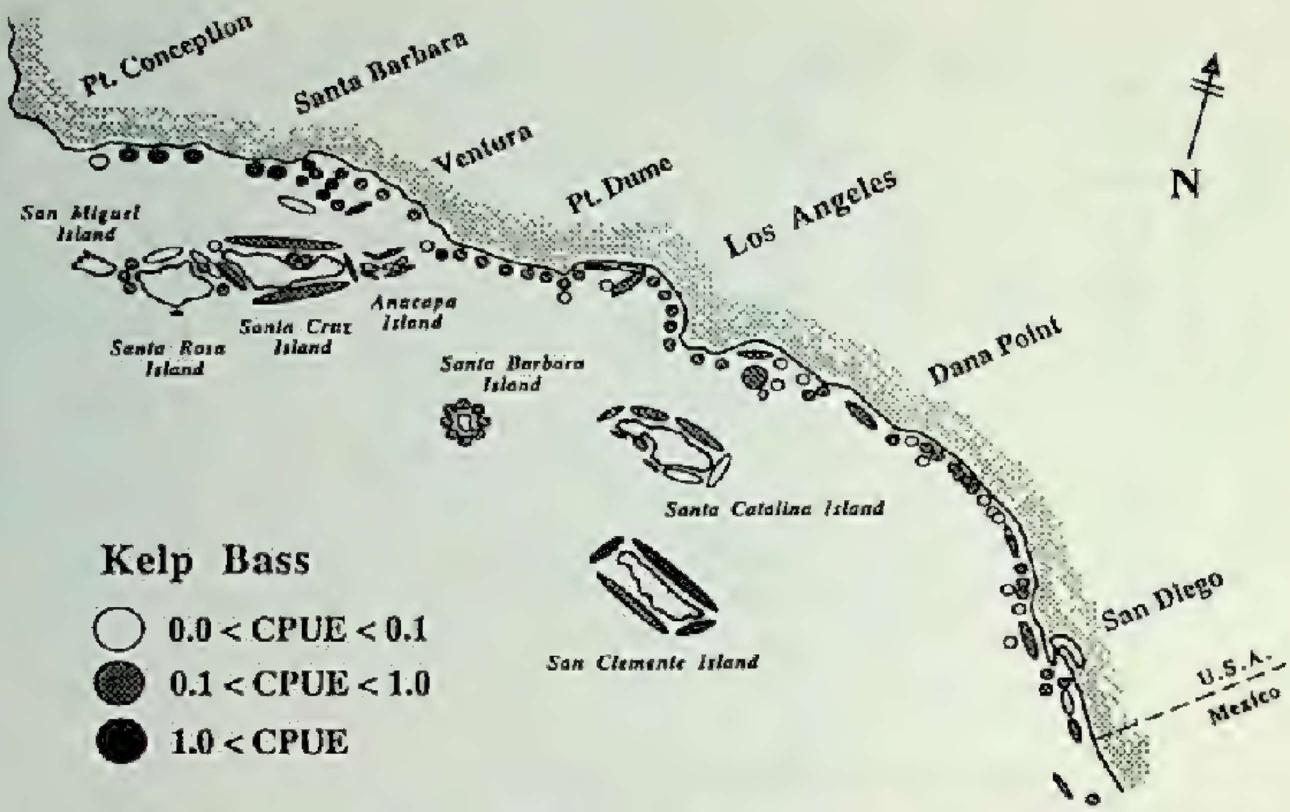

Figure 3. Catch per angler-h (CPUE) for kelp bass taken in the Southern California Bight by the commercial passenger fishing vessel fishery, 1986-1989. Due to space limitations, the following Santa Cruz Island locations with CPUE >1.0 are illustrated as one site: Chinese Harbor, Smugglers Cove, San Pedro Point, Scorpion Arch, and Yellow Banks. One other high CPUE site, Avalon Bay, Santa Catalina Island, is not shown.

heavily populated and contains larger recreational fishing fleets. Moreover, the southern areas are less affected by storms and have more fishable days. The same reasoning helps explain the productivity of most of the San Clemente Island sites. That island is one of the most remote in southern California and, except for the leeward side, receives less attention from recreational fishermen than sites closer to ports.

Avalon Bay on Santa Catalina Island ranked third in CPUE, even though Santa Catalina Island is heavily fished. Avalon, the only developed harbor on the island, is fished continuously by both CPFVs and private vessels. One possible reason for the abundance of kelp bass in and around the bay is the heavy daily feeding they receive from local glass-bottom tour boats. As these vessels cruise the local reefs, they toss food into the water, which brings kelp bass under the vessel, where they are visible to passengers. Feeding may occur hourly during daytime. The large numbers of kelp bass in the bay may be attracted to, and held in the vicinity, by this continual feeding. Kelp bass larval recruitment is higher at Catalina Island than at a mainland site (Carr 1994) and this also may help explain the phenomenon. In addition, there is a marine refuge close to Avalon, where no fishing is allowed. Kelp bass from the refuge may wander over to Avalon and enter the recreational fishery.

In contrast to kelp bass, the areas with highest CPUE for barred sand bass were distributed along the mainland from Ventura into Baja California (Fig. 5, Table 4). Nine sites yielded CPUEs >1.0 barred sand bass per angler-h. Barred sand bass prefer lower relief sites away from rocky headlands; they are often found in mid-bay (e.g., Santa Monica Bay) or along sandy stretches of coast. Most fishing effort for barred

Table 3. Commercial passenger fishing vessel kelp bass fishing sites in the Southern California Bight with catch per angler-h ≥1.0. Based on 1986-89 data, excluding sites with <100 angler-h effort. Except Cardiff-by-the-Sea (located near Oceanside), all mainland sites are located within 30 km of Santa Barbara.

Rank	Site name	Effort	CPUE
1	Oil Platforms Hilda and Hazel	529.8	2.4
2	Naples Reef	298.2	2.3
3	Avalon Bay, Santa Catalina I	210.2	2.2
4	Chinese Harbor, Santa Cruz I	222.7	1.7
5	Smugglers Cove, Santa Cruz I	707.5	1.7
6	East End, San Clemente I	146.4	1.7
7	East End, Santa Cruz I	142.7	1.6
8	West End, San Clemente I	328.2	1.5
9	Camby's Reef	441.7	1.5
10	Mohawk Reef	169.0	1.5
11	Horseshoe Kelp[a]	550.2	1.4
12	Ellwood	240.9	1.4
13	Hendry's Beach	130.7	1.2
14	San Pedro Pt., Santa Cruz I	878.9	1.1
15	Scorpion Arch, Santa Cruz I	539.1	1.1
16	Isla Vista Reef	208.4	1.1
17	Rincon Oil Platforms	210.2	1.1
18	Horseshoe Reef	673.6	1.1
19	Yellowbanks, Santa Cruz I	1,579.0	1.1
20	Cardiff-By-The-Sea	555.3	1.0
21	Leeward Side, San Clemente I	1,035.3	1.0
22	Flag Reef	634.4	1.0

[a] In southern California, there are two sites called "Horseshoe Kelp". This one is a small reef located just south of Santa Barbara, not the large structure situated offshore of the San Pedro-Long Beach Harbor.

sand bass occurs during the late spring-early fall spawning season, when CPFV operators target large spawning aggregations. During the non-reproductive period, the fish tend to be found in small groups near low relief. Thus, sites with the highest CPUE may represent spawning areas for the species. In general, these are areas of low relief or hard bottom, often in 20-40 m. While barred sand bass are abundant all along the coast, they are relatively rarely caught around the islands of the bight, despite a great deal of fishing pressure and a fair amount of suitable habitat, at least around Santa Catalina and Santa Cruz islands.

Depth Distribution

While kelp bass weretaken at sites with bottom depths from <10 to>50 m, they were most abundant at depths<30 m (Fig. 6). Catches decreased in 31-40 m and few fish were taken in deeper water. Seasonal catch patterns implied an offshore

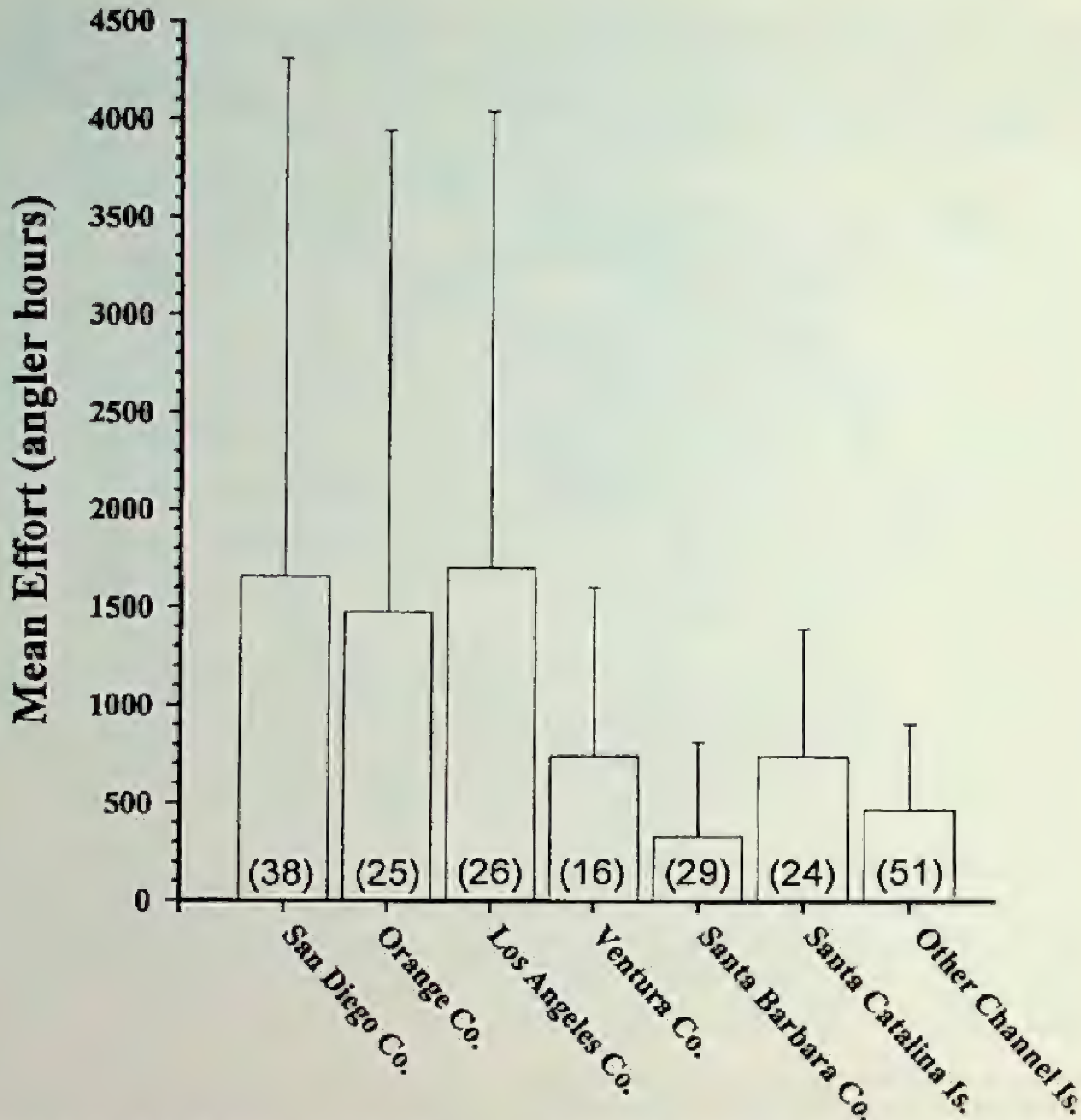

Figure 4. Mean total effort expended over the 4-year period, 1985-1988, in seven regions of the Southern California Bight. Error bars represent +/- one standard error about the mean. Numbers in parenthesis refer to the number of locations fished in each region.

movement of fish during spring, at least from the shallowest depths. Of all depths and seasons, CPUE's were highest in <10 m during winter. By spring, catches in these depths had decreased by almost a factor of 3, corresponding with movements to the deeper water noted by Quast (1968). This offshore movement may be related to this species' small-scale spawning migrations (Feder et al. 1974). Since our analysis was only based on sites harboring kelp bass, the declining CPUE in0-10 m during spring and summer is not due to a shift in CPFV fishing sites.

Barred sand bass were taken in depths ranging from <10 to >50 m (Fig. 6), with highest catches in11-50 m. Depths of the summer spawning aggregations (centered between 21 and 40 m) are apparent. Compared to other seasons, catches were considerably higher during the summer months in 21-40 m. Some slight winter inshore movement may occur, as catches during the winter in the shallowest areas (<10 m) were higher than in other seasons.

Figure 5. Catch per angler-h (CPUE) for barred sand bass taken in the Southern California Bight by the commercial passenger fishing vessel fishery, 1986-1989.

Table 4. Commercial passenger fishing vessel barred sand bass fishing sites in the Southern California Bight with catch per angler-h >1.0. Based on 1986-89 data, excluding sites with <100 angler-h effort. Sites are designated by the closest large city.

Rank	Site name	Effort	CPUE
1	Rincon Pt. - Loon Pt. (Ventura)	147.0	4.5
2	Silver Strand (San Diego)	508.0	1.6
3	"Sand Bass Junction" (Long Beach)	1,443.4	1.4
4	San Clemente Reef (San Clemente)	1,328.0	1.4
5	Ventura Harbor-Pitas Pt. (Ventura)	3,434.5	1.3
6	Seal Beach (Long Beach)	772.3	1.3
7	Shale Spot (Ventura)	1,225.0	1.3
8	Huntington Flats (Huntington Beach)	12,117.0	1.1
9	Inner Santa Monica Bay (Santa Monica)	3,088.0	1.1

Total length for both kelp bass and sand bass exhibited a positive relationship with depth of capture during the 1970s (kelp bass: slope = 0.29, F = 16.76, P <0.001; barred sand bass: slope = 3.96, F = 631.60, P <0.001) and the 1980s (kelp bass: slope = 0.31, F = 92.74, P <0.001; barred sand bass: slope = 0.74, F = 381.89, P <0.001), suggesting that small individuals are caught in shallower depths. In spite of the significance of these regressions, depth actually explained very little of the total variation in length of the catch of either species during either the 1970s (kelp bass: $r^2 = 0.001$; barred sand bass: $r^2 = 0.059$) or the 1980s (kelp bass: $r^2 = 0.003$; barred sand bass: $r^2 = 0.017$) and fish of all sizes were taken in all depths sampled.

Size Frequencies

Mean total length of kelp bass taken in the CPFV fishery during the years 1975-1978 was 33.6 cm. This value increased slightly to 33.7 cm during the period 1986-1989 (Fig. 7), but this increase was not statistically significant ($t' = 1.55$, $P > 0.05$). Mean total length of barred sand bass decreased significantly from 35.7 cm in the 1970s to 35.3 cm during the 1980s ($t' = 4.47$, $P < 0.001$) (Fig. 8). Such a small decrease in size is probably not biologically significant.

To determine if kelp bass and barred sand bass were subject to growth overfishing (manifested as a decrease in the proportion of large fish in the catch), we tested for differences between the 1970s and 1980s in the percentage of the catch that was >30.5 cm (the minimum legal length). Length-frequency distributions of the catches

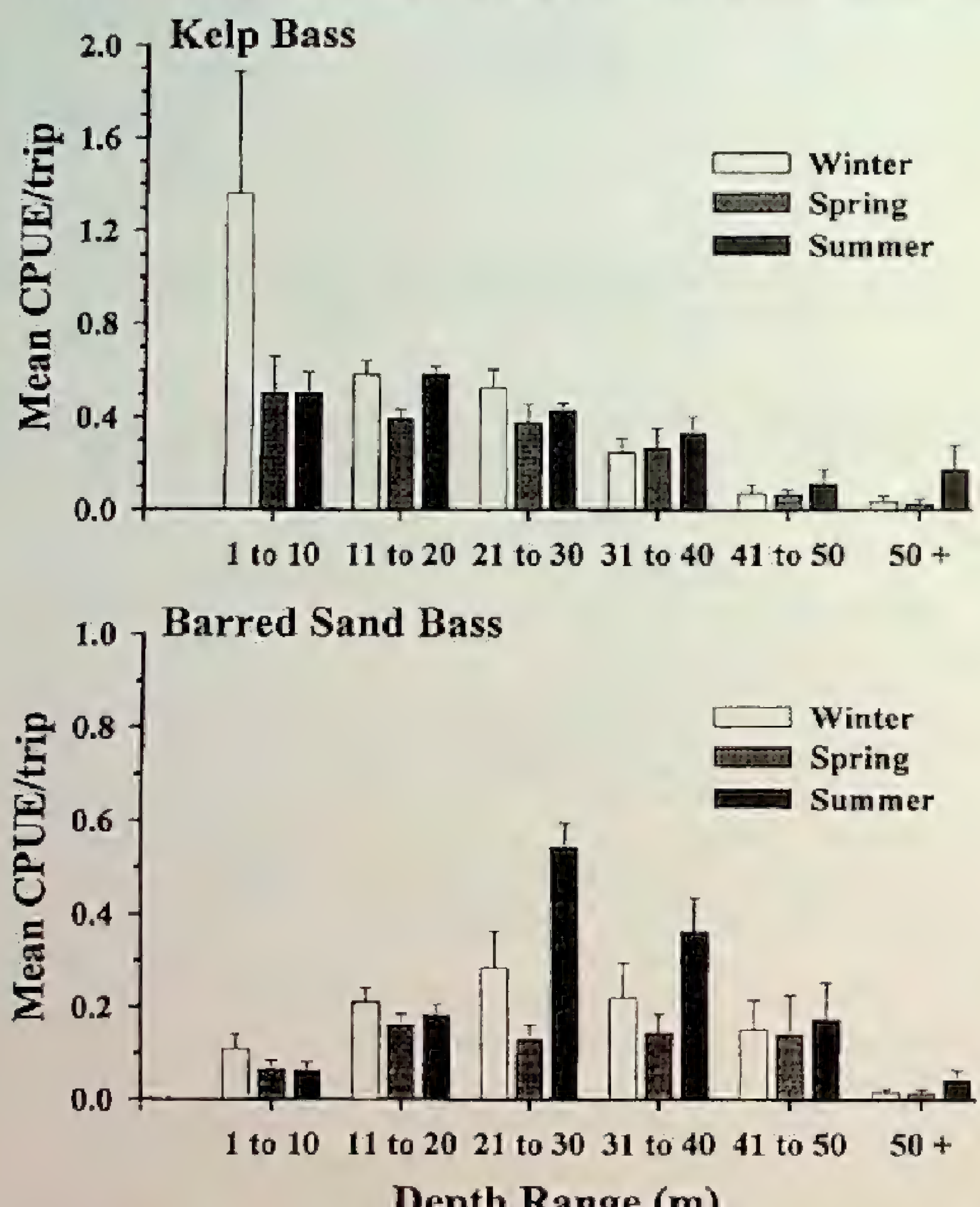

Figure 6. Variability in catch/angler-h with depth for kelp bass and barred sand bass in the southern California commercial passenger fishing vessel fishery, 1986-1989. Error bars are +/- one standard error about the mean.

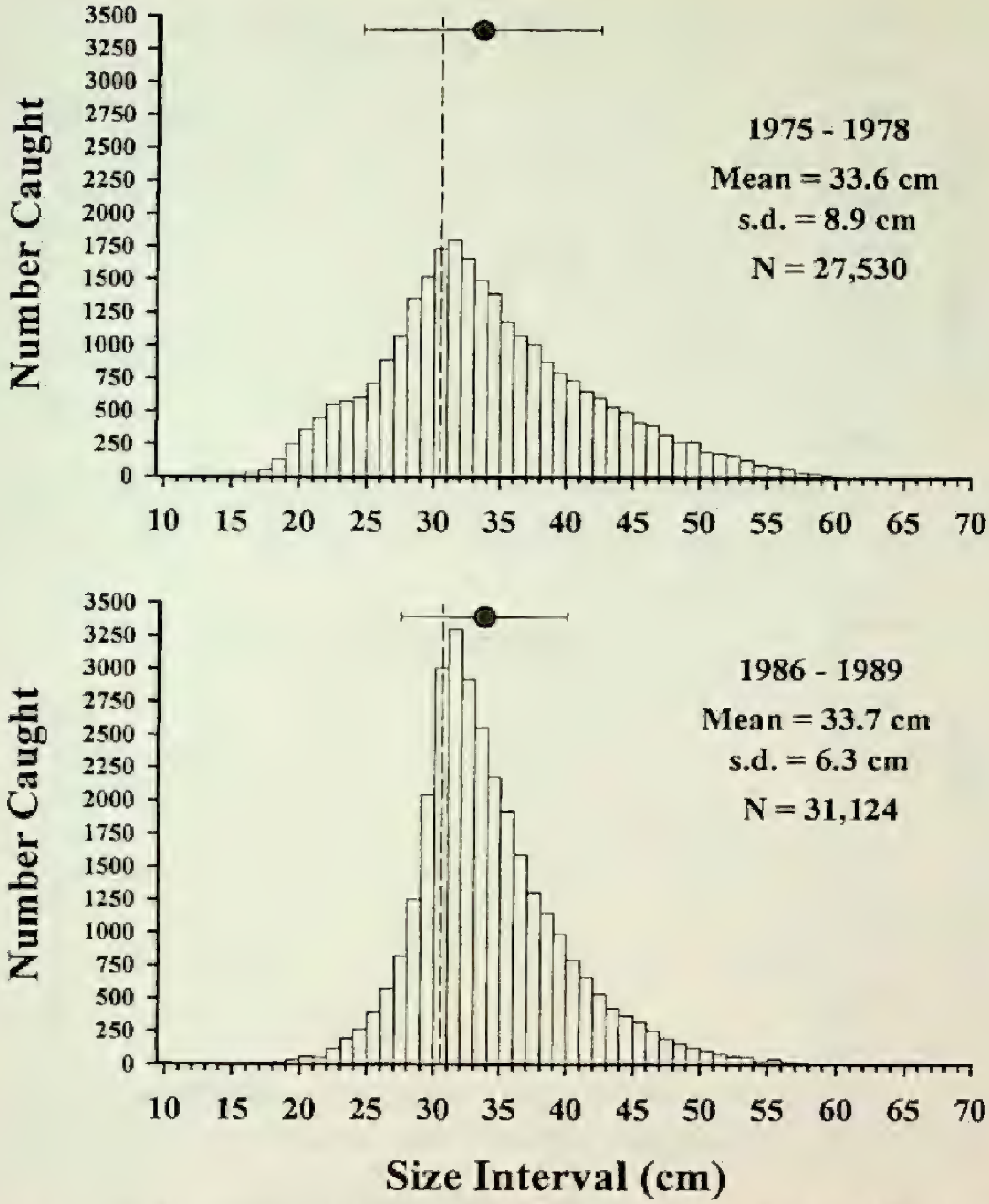

Figure 7. Length frequency distribution of kelp bass caught in the southern California commercial passenger fishing vessel fishery, 1975-1978 and 1986-1989. Vertical dashed lines represent the minimum legal size limit and the black circle indicates the sample mean length, +/- one standard deviation about the mean.

(Fig. 7 and 8) indicate that the fishery did not crop out the larger fish between the 1970s and 1980s. In fact, the percentage of the catch above legal size increased significantly, from 65% to 77% for kelp bass ($\chi^2 = 1{,}532.0, P < 0.0001$) and from 83% to 88% for barred sand bass ($\chi^2 = 211.0, P < 0.001$).

The proportion of legal-sized to sublegal fish likely reflects the success of recruitment in previous years. For instance, the sharp decrease in the proportion of legal-sized kelp bass between 1976 and 1978 closely parallels increased recruitment success beginning in 1976 off Redondo Beach (Stephens et al. 1986).

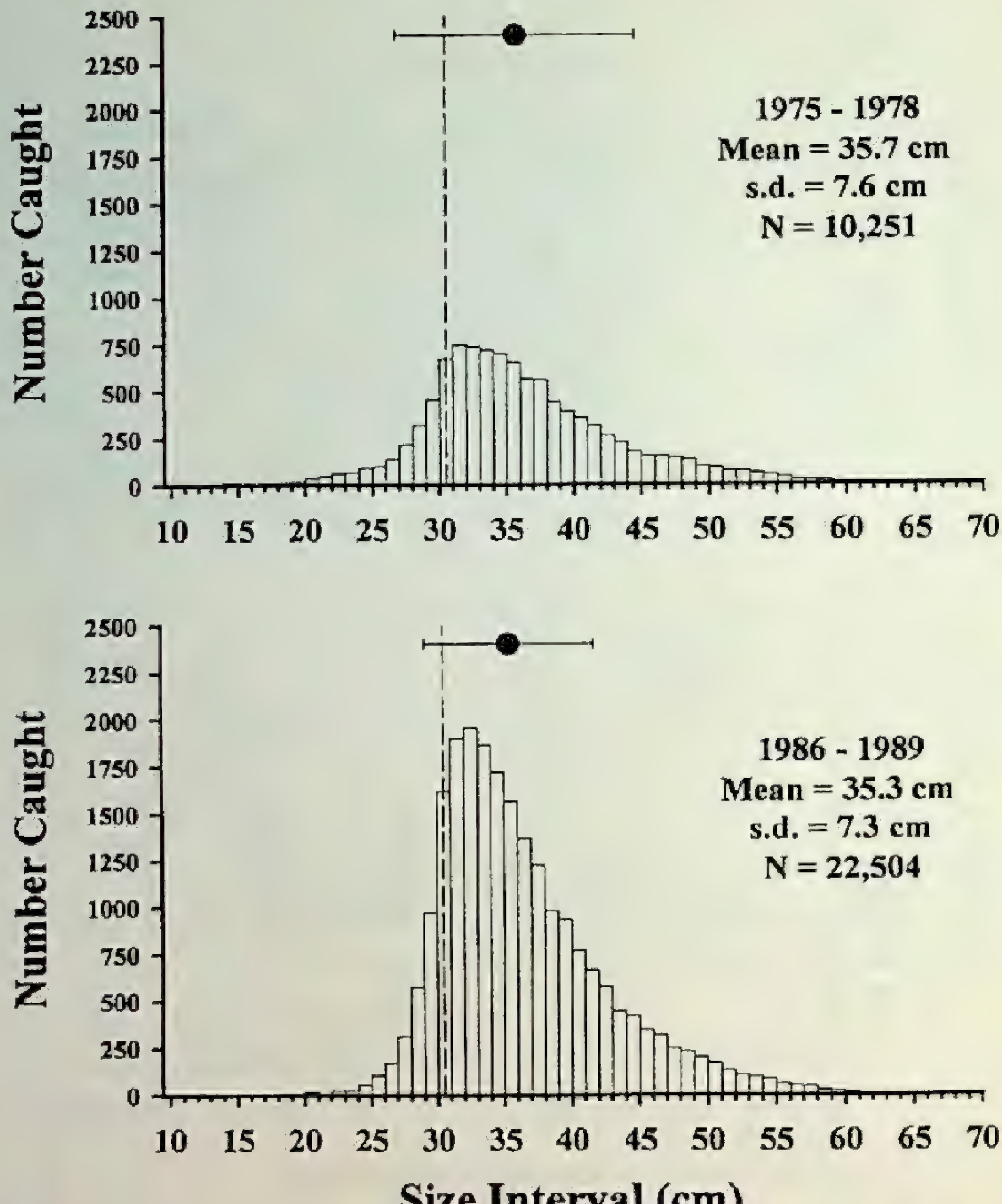

Figure 8. Length frequency distribution of barred sand bass caught in the southern California commercial passenger fishing vessel fishery, 1975-1978 and 1986-1989. Vertical dashed lines represent the minimum legal size limit and the black circle indicates the sample mean length, +/- one standard deviation about the mean.

Seasonality

During 1986-89, kelp bass CPUE was highest in late spring and fall (Fig. 9). Catches were low from January through March, rose to a May-June peak, then declined during summer to an August low. A second, and higher, peak occurred in October. Catches during the October peak were 4 times those of the February low.

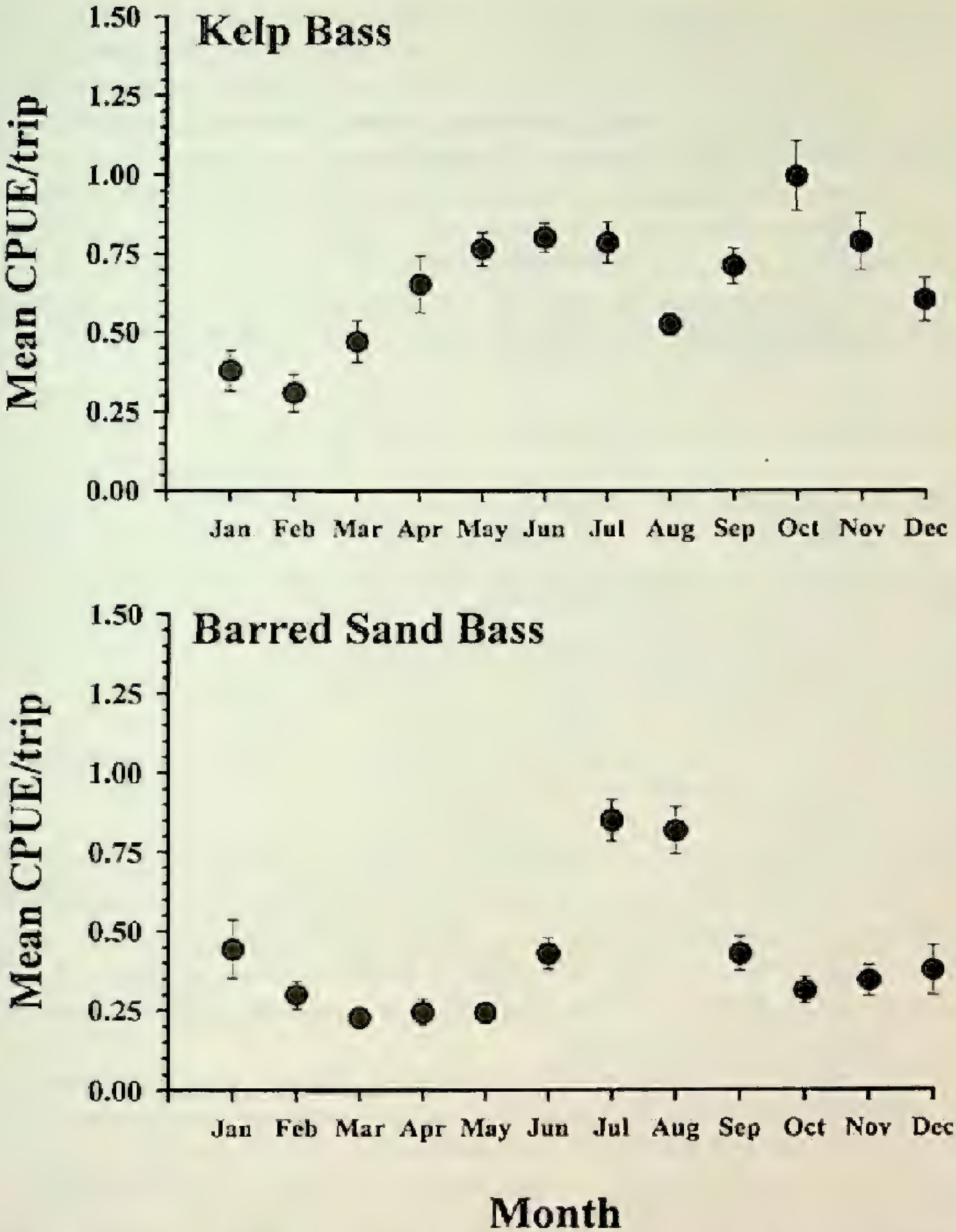

Figure 9. Monthly variability in mean catch/angler-h of kelp bass and barred sand bass taken in the southern California commercial passenger fishing vessel sport fishery during the years 1986-1989. Error bars are +/- one standard error about the mean.

The low catches during winter may be due to the effects of lower water temperatures on metabolism and feeding. Other factors may be responsible for the spring and fall peaks and summer low. Quast (1968) reported a similar pattern in CPUE of kelp bass taken from June-October 1958 aboard a single CPFV fishing off San Diego. He found no significant correlations between CPUE and environmental factors (including tides, weather, lunar phases, and surface temperatures) and suggested that kelp bass

spawning condition might have been a significant factor. He theorized that kelp bass feed more heavily during spawning. However, based on his data, most spawning appears to occur from July-September and the spring catch maximum comes just before, and the October maximum just after, the peak spawning period. Rather than feeding more during spawning season, kelp bass may feed less.

Barred sand bass catches showed a different pattern. Catches were relatively low throughout the year, except for a summer (July-August) peak (Fig. 9). Catch per unit effort varied by a factor of 4 between the May low and July high. As mentioned before, this species is a summer spawner and the catch pattern reflects the targeting of spawning aggregations with their greatly increased concentrations of barred sand bass.

Future of the Fishery

The data presented here demonstrates the importance of kelp bass and barred sand bass to the CPFV fleet. Even during the 1970s, when catches of both species were considerably lower than during the 1980s, these species ranked high in CPUE relative to other fishes. The CPFV fishery frequently targets both kelp bass and barred sand bass, while other species represent incidental catch.

Kelp and barred sand bass fisheries appear to be in good condition. The bass populations (as indexed by CPUE), bolstered by minimum length regulations, increased between the 1970s and 1980s, while the overall size structure of the catch has remained relatively stable. Thus, the bass fisheries are currently managed to optimize the quantity of bass caught, rather than size.

However, some anglers feel that there are not enough large, "trophy" fish in the population and that actions to improve the quality (as opposed to the quantity) of the bass fishery, particularly for kelp bass, are necessary. Their solution is to return virtually all bass caught. This is an almost revolutionary concept for the CPFV anglers of southern California. Traditionally, these anglers have kept virtually all the legal-sized popular species caught.

Our observations over the last 20 years show that there were several reasons for this "catch and keep" phenomenon. First, for many anglers, the fish they catch are a food source. Second, there is a competitive aspect to catching the most fish; full sacks mark the successful angler. In addition, CPFV operators and crews encourage fish retention in order to (i) bolster the number of fishes taken and make all passengers happy, (ii) attract future customers when "fish counts" of each landing are listed in the daily newspapers, and (iii) maximize income that comes from cleaning fish at the end of the trip.

Opposing these long-held behaviors are a small, but growing, group which points out that returning fish is no longer an unusual circumstance among other groups of recreational fishermen. We found that several CPFV operators are encouraging their passengers to release unwanted kelp bass (M. McCrae, F/V *SEAHAWK*, Sea Landing, Santa Barbara, California, pers. comm.). Mr. McCrae explains over the vessel's public address system that the reef they are fishing is small; can be easily fished out; and that, if they release the kelp bass, the fish may be there the next time they fish that reef.

Kelp bass is an excellent species for a catch and release program. It is taken in shallow water, so the inflated swimbladder problems found in deeper-dwelling species (such as rockfishes) are nonexistent. It is also very hardy; our observations show that almost all kelp bass hooked can be released without fatally injuring the fish. Finally, at least some kelp bass populations seem to be resident, so a catch and release program should show results within a relatively few years.

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CONDITION AND REPRODUCTIVE PERFORMANCE OF FEMALE MULE DEER IN THE CENTRAL SIERRA NEVADA

T. J. TAYLOR
P.O. Box 191
June Lake, California 93529

I determined reproductive performance in relation to age and physical condition of 58 female Rocky Mountain mule deer, *Odocoileus hemionus hemionus*, collected from the West Walker winter range in northern Mono County, California, and southwestern Douglas County, Nevada during March 1993 and March 1994. Among adult females, pregnancy and fetal rates were 86% and 1.52 fetuses/female in 1993 and 88% and 1.56 fetuses/female in 1994. Bled carcass weights, eviscerated carcass weights, and kidney fat indices of adult females were greater in 1994, indicating that deer were in better condition than in 1993. Litter category was not related to age or female body condition. The overall sex ratio of fetuses was 107 males:100 females. Reproductive potential in the West Walker deer herd was comparable to that reported for other nutritionally stressed mule deer populations. My study suggested that low productivity was in response to drought-induced changes in habitat quality.

INTRODUCTION

During 1987-1994, Rocky Mountain mule deer, *Odocoileus hemionus hemionus*, populations in the eastern Sierra Nevada, California, experienced poor fawn survival and low recruitment. For example, fall fawn ratios for the West Walker (WW) deer herd in northern Mono County averaged 26 fawns:100 females, while spring ratios averaged 20 fawns:100 females (R. Thomas, California Department of Fish and Game, pers. comm.). This low recruitment was concomitant with 7 consecutive years of drought, which subjected this deer population to repeated episodes of nutritional stress.

Nutrition is an important factor influencing productivity of deer populations (Verme 1967, McCullough 1979) because it affects the proportion of females that become pregnant, as well as ovulation rates (Sadleir 1987, Folk and Klimstra 1991). These effects are well documented for free-ranging (Morton and Cheatum 1946, Julander et al. 1961, Kucera[1] 1988) and captive deer (Verme 1965, 1967; Ozoga and Verme 1982). Research consistently has shown that deer on good quality ranges have higher rates of ovulation, conception, and pregnancy than deer on poor ranges.

An understanding of the relationships between body condition and reproductive performance of wild ungulate populations is necessary for their management

[1] Kucera, T.E. 1988. Ecology and population dynamics of mule deer in the eastern Sierra Nevada, California. Ph.D. Dissertation, University of California, Berkeley, California, USA.

(Saltz et al. 1992). Therefore, a high priority in any deer herd where fawn production is suboptimal should be to evaluate the physical condition of females during breeding and pregnancy (Connolly 1981, Saltz et al. 1992).

Body fat is the component most often associated with animal condition and can be used to index animal response to nutritional and climatic stressors (Robbins et al. 1974, Torbit et al. 1985). Various fat indices have been developed to estimate body condition, including bone marrow fat (Cheatum 1949; Riney 1955; Ransom 1965, 1967), kidney fat (Riney 1955; Ransom 1965, 1967; Batcheler and Clark 1970; Van Vuren and Coblentz 1985), and visual scoring methods (Ransom 1965, Kistner[2] 1976). I used kidney fat indices and reproductive tracts to determine the physical condition and reproductive potential of adult female mule deer collected from the WW deer herd during March 1993 and March 1994. My objectives were to (i) assess the effects of a prolonged drought, followed by an unusually severe winter, on the spring condition of female mule deer and (ii) compare the effects of an unusually severe and an unusually mild winter on deer condition and productivity. This descriptive study is intended to provide information on mule deer condition and reproduction in order to facilitate a better understanding of interactions that occur between the WW deer herd and its environment.

STUDY AREA AND METHODS

During 18-19 March 1993 and 15-16 March 1994, free-ranging female mule deer were collected from WW winter ranges in northern Mono County, California, and southwestern Douglas County, Nevada (Fig. 1). Winter range of the WW herd encompasses approximately 780 km^2 at elevations from 1,530 to 2,550 m. Dominant plant communities (following Mayer and Laudenslayer 1988) on the winter range include bitterbrush, *Purshia* sp.; sagebrush, *Artemisia* sp.; and pinyon pine, *Pinus monophylla*. Descriptions of WW herd ecology, winter range vegetation, climate, and topography have been reported by Thomas[3] (1985), Loft et al. (1989), and Taylor[4] (1993).

Deer were collected by two-person teams that shot the first identifiable adult or yearling female in each group of deer encountered, regardless of the animal's apparent body condition. Animals were shot in the head, neck, or thorax with a high-powered rifle. Carcasses were transported to a field processing station where they were weighed to the nearest kilogram (bled carcass weight, BCW) using a spring scale. External body measurements (chest girth, left hind foot length, and contour length) to the nearest centimeter were recorded. Animals were eviscerated and reproductive tracts (uterus and ovaries), right kidneys, right femurs, and lower jaws

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[2] Kistner, T.P. 1976. Evaluating physical condition of deer. Oregon Department of Fish and Wildlife, Portland, Oregon, USA.

[3] Thomas, R.D. 1985. Management plan for the West Walker deer herd. California Department Fish and Game, Bishop, California, USA.

[4] Taylor, T.J. 1993. West Walker deer herd progress report 2. California Department Fish and Game, Bishop, California, USA.

Figure 1. Locations of deer collection areas on the West Walker deer herd winter range in Mono County, California and Douglas County, Nevada, 1993-1994.

were extracted. Ages were estimated by tooth wear and replacement (Larson and Taber 1980). After field necropsies were completed, deer were weighed to the nearest kilogram to determine eviscerated carcass weights (ECW). The kidney fat index (KFI, Riney 1955) was calculated by dividing the fresh weight of kidney fat by the fresh weight of the fat-free kidney, multiplied by 100.

Ovaries were sectioned at 5-mm intervals and examined macroscopically for corpora lutea of pregnancy (CLP), which were used to estimate ovulation rates. I used a fetus scale (Forestry Suppliers Inc., Jackson, Mississippi, USA) to determine forehead-rump lengths of fetuses in order to estimate fetal age (Hudson and

Browman 1959) and conception and fawning dates. Conception date was back-calculated from estimated fetal age. Approximate date of parturition was determined by adding 204 d (Anderson 1981) to conception date. Weather data were obtained from the National Oceanic and Atmospheric Administration weather station in Coleville, California.

I used standard techniques for statistical testing with $\alpha = 0.05$. Analysis of variance was used to test for differences in mean reproductive characteristics and condition indices between years and among collection areas and to examine the relationship between "litter category" (number and sex composition of litters, i.e., single female, twin females, single male, etc.) and BCW, ECW, and KFI. Kidney fat indices were normalized by logarithmic transformation prior to analysis. I tested for deviations from the expected 1:1 sex ratio among fetuses with a binomial test (Siegel 1956); deviations from the expected distribution of sex ratios among litter categories were tested using chi-square analyses. I also used chi-square tests to examine differences in fetal sex ratio between years and among collection areas. Means and standard errors were calculated from untransformed data.

RESULTS

Deer (29 each year) were collected from three primary areas within the range that supported deer concentrations during all winters. A total of 20 deer (10 each year) were collected from Little Antelope Valley (LAV), California; 20 deer (10 each year) were collected from the east side (ES) of Antelope Valley near the base of the Wellington Hills, Nevada; and 18 deer (nine each year) were collected from the vicinity of Topaz Lake (TL), Nevada (Fig. 1).

Winter weather in 1992-93 was severe, with 180 cm of snow and average minimum temperatures of -16°C in January. In comparison, the winter of 1993-94 was mild, with 81 cm of snow and minimum temperatures averaging -6°C in January.

Pregnancy and fetal rates were similar in 1993 and 1994 and mean age (4.9 yr in 1993 and 5.2 yr in 1994) of adult females did not differ significantly between years($F = 0.227$; 1, 54 df; $P = 0.972$). Among adult females examined, 25 of 29 (86%) were pregnant in 1993and 24 of 27 (88%) were pregnant in 1994 (Table 1). Mean fetal rates of 1.52 fetuses per adult female in 1993 and 1.56 fetuses in 1994 did not differ between years ($F = 0.357$; 1, 54 df; $P = 0.553$), and mean fetal rates did not differ among collection areas($F = 0.001$; 2, 53 df; $P = 0.999$) (Table 1). Of the 29 adult femalescollected in 1993 for which ovaries were examined, 46 CLP resulted in 44 viable, implanted fetuses. Of the 27 adults collected in 1994, 45 CLP resulted in 43 viable, implanted fetuses.

Estimated breeding and parturition dates were similar in both years. Ages of fetuses in 1993 indicate that breeding occurred between 23 November and 30 December, with a median date of 6 December. In 1994, breeding occurred between 28 November and 14 December, with a median date 7 December. Predicted parturition for deer examined in 1993 ranged from mid-June to mid-July; the median was 2 July. In 1994, predicted parturition ranged from 20 June to 7 July; the median was 28 June.

Table 1. Frequency of fetuses in adult Rocky Mountain mule deer collected from the West Walker deer herd winter range in March 1993 and March 1994, Mono County, California and Douglas County, Nevada. LAV = Little Antelope Valley, ES = East Side, TL = Topaz Lake.

Location	No. of does with litter size of 0	1	2	3	Total no. of fetuses	Total no. of does	Mean fetuses per doe	Mean fetuses/ pregnant doe
1993								
LAV	0	4	6	0	16	10	1.60 ± 0.52	1.60 ± 0.52
ES	3	1	5	1	14	10	1.40 ± 1.07	2.00 ± 0.58
TL	1	2	6	0	14	9	1.55 ± 0.72	1.75 ± 0.46
1994								
LAV	0	2	7	0	16	9	1.77 ± 0.44	1.77 ± 0.44
ES	2	2	5	0	12	9	1.33 ± 0.86	1.71 ± 0.49
TL	1	1	7	0	15	9	1.67 ± 0.79	1.88 ± 0.35

Deer were in better condition in 1994 than in 1993 (Table 2). Mean BCW of adult females (44.5 kg in 1993 and 50.9kg in 1994) differed between years ($F = 13.79$; 1, 54 df; $P < 0.001$); however, mean BCW did not differ among collection areas ($F = 0.170$; 2, 53 df; $P = 0.193$), and year by area interaction was not significant ($F = 0.360$; 1, 54 df; $P = 0.700$). Eviscerated carcass weights of adult females followed a similar trend, differing between years ($F = 25.57$; 1, 54 df; $P < 0.001$), but not among collection areas ($F = 2.05$; 2, 53 df; $P = 0.141$); year by area interaction also was not significant ($F = 0.095$; 1, 54 df; $P = 0.910$). Mean KFI was significantly lower in 1993 (9.3%) than in 1994 (36.0%) ($F = 29.53$; 1, 54 df; $P < 0.001$), but did not differ among the three collection areas ($F = 0.939$; 2, 53 df; $P = 0.399$); year by area interaction was not significant ($F = 0.124$; 1, 54 df; $P = 0.884$).

West Walker females produced more male than female fetuses. However, the overall sex ratio of fetuses, 1.07:1.00 in favor of males (45 males:42 females), was not significantly different from unity ($Z = -0.21$, $P = 0.83$) (Table 3). Single fetuses were present in 12 of 49 pregnant females, 36 carried twins, and one had triplets (Table 1). Among the 12 litters of singletons, four fetuses were male and eight were female. Among the 36 sets of twins, 18 were of mixed sex, 9 were twin females, and 9 were twin males. These frequencies of sex ratio categories were not different from random expectation ($\chi^2 = 4.5$, 2 df, $P = 0.105$). Sex ratios of fetuses in 1993 and 1994 did not differ ($\chi^2 = 0.57$, 1 df, $P = 0.451$). Overall, sex ratio categories did not differ among collection areas ($\chi^2 = 5.28$, 2 df, $P = 0.072$), but in 1994 LAV and TL females produced significantly more male fetuses than did ES females ($\chi^2 = 11.3$, 2 df, $P = 0.004$) (Table 3). I found no relationship between litter category and maternal age ($F = 1.55$; 5, 43 df; $P = 0.208$), nor between litter category and BCW ($F = 1.61$; 5, 43 df; $P = 0.178$), ECW ($F = 0.846$; 5, 43 df; $P = 0.52$) and KFI ($F = 1.63$; 5, 43 df; $P = 0.173$).

Table 2. Mean bled carcass weight (BCW), eviscerated carcass weight (ECW), and kidney fat index (KFI) for 56 adult female Rocky Mountain mule deer collected on the West Walker deer herd winter range in March 1993 and March 1994, Mono County, California and Douglas County, Nevada. LAV = Little Antelope Valley, ES = East Side, TL = Topaz Lake.

		BCW (kg)		ECW (kg)		KFI (%)	
Location	n	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
1993							
LAV	10	44.1	4.52	31.0	3.28	7.2	3.05
ES	10	42.6	5.07	30.2	2.64	9.2	5.88
TL	9	47.1	7.57	34.1	5.04	11.4	9.09
Total	29	44.5	5.90	31.7	3.97	9.3	6.38
1994							
LAV	9	49.7	3.82	35.7	2.24	45.4	27.22
ES	9	51.0	6.16	36.8	4.47	32.2	24.05
TL	9	52.1	4.39	38.6	4.08	30.4	10.72
Total	27	50.9	4.75	37.0	3.79	36.0	22.09

Table 3. Sex of fetuses from 49 adult female Rocky Mountain mule deer collected on the West Walker deer herd winter range in March 1993 and March 1994, Mono County, California and Douglas County, Nevada. LAV = Little Antelope Valley, ES = East Side, TL = Topaz Lake.

Location	Male (N)	Female (N)	% Male
1993			
LAV	7	9	43.7
ES	7	7	50.0
TL	7	7	50.0
Total	21	23	47.7
1994			
LAV	10	6	62.5
ES	2	10	16.6
TL	12	3	80.0
Total	24	19	55.8

DISCUSSION

Reproductive rates observed during this study were similar to those reported by Bischoff (1958), Jordan[5] (1967), and Kucera[1] (1988) for other central Sierra Nevada mule deer populations. I detected no significant differences in measures of reproduction between years, despite significant increases in measures of body condition in 1994. Fetal rates during this study were 1.52 fetuses/doe in 1993 and 1.56 fetuses/doe in 1994; mean KFI's increased from 9% in 1993 to 36% in 1994.

[5] Jordan, P.A. 1967. Ecology of migratory deer in the San Joaquin River drainage. Ph.D. Dissertation, University of California, Berkeley, California, USA.

In the eastern Sierra Nevada, Taylor[6] (1991) documented reproductive rates on two mule deer winter ranges of 1.88 and 1.93 fetuses/doe when KFI's averaged 32% and 25%, respectively. Kucera[1] (1988) found low reproductive rates (1.06-1.42 fetuses/female) among mule deer when mean KFI's averaged 10-27%; a higher reproductive rate (1.88 fetuses/female) was observed with mean KFI >60%. Taylor[7] (1988) reported that mule deer from the CasaDiablo herd had reproductive rates of 1.74 and 1.70 fetuses/doe when KFI's averaged 41% and 37%, respectively. These incongruous data suggest that KFI may not be an accurate basis for determining the effects of nutritional status on deer productivity when comparing disparate populations.

I surmise that increases in deer condition during 1994 were largely due to the wet winter of 1992-93, which enhanced forage production during the spring and summer of 1993, and increased forage availability during the winter of 1993-94. Kucera[1] (1988) reported large increases in forage production on two mule deer winter ranges in the eastern Sierra Nevada following winters of heavy precipitation, which in turn were mirrored by high measures of condition and reproduction. In contrast, my findings indicate that deer productivity in 1994 was not measurably affected by significant increases in body condition. Following the winter of 1992-93, deer may have so exhausted their body reserves that they were not able to attain the threshold of body condition necessary to enhance their reproductive potential, despite greater forage availability during spring and summer 1993. In years of high forage availability that follow extreme winters, it may not be possible for some deer to achieve enhanced reproductive performance.

The cumulative effects of drought on summer range forage production presumably had a major influence on deer reproduction in 1993. Of 29 adult females, three were without corpora lutea and seven had one corpus luteum each for an ovulation rate of 1.59 CLP per female. This low ovulation rate indicated that summer ranges occupied by WW deer were of poor nutritional quality and, presumably, were inadequate to allow female deer to achieve peak body condition prior to the breeding season. Short (1981) surmised that when summer ranges provide low quality forage because of drought or other factors, the high metabolic requirements of females are not met and requirements for reproduction are not satisfied. Bertram[8] (1984) reported a pronounced decline in reproductive potential among female mule deer collected from the North Kings herd following the dry spring, summer, and fall of 1977. Several other researchers (Robinette et al. 1955, Swank 1958, Taberand Dasmann 1958, Julander et al. 1961) determined that summer forage nutrition influenced ovulation rates and the number of fetuses produced per female.

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[6] Taylor, T.J. 1991. Ecology and productivity of two interstate deer herds in the eastern Sierra Nevada: East Walker-Mono Lake deer herd study. California Department of Fish and Game, Bishop, California, USA.

[7] Taylor, T.J. 1988. The Casa Diablo deer herd: Reproduction and condition 1987-1988. Casa Diablo deer herd study. California Department of Fish and Game, Bishop, California, USA.

[8] Bertram, R.C. 1984. The North Kings deer herd study. California Department of Fish and Game, Fresno, California, USA.

Mean KFI of 9% observed in March 1993 is similar to values reported by Kucera[1] (1988) and Anderson et al. (1972) for other nutritionally stressed mule deer populations. KFI values <15% indicate essentially no fat, and represent the point when animals begin to mobilize femur marrow fat for energy (Ransom 1965, Pojar and Reed 1974, Kie et al. 1983). Animal condition, as indexed by KFI and BCW, was lowest following the severe winter of 1992-93, when snow accumulations on primary winter ranges (1,700 m elevation) totaled 180 cm and lasted from 7 December to 3 March. This prolonged snow cover buried sources of forage and, when coupled with persistent low temperatures, resulted in widespread starvation (T.J. Taylor, unpubl. data) and decreased maternal nutrition and productivity among surviving females. Severe winters have been associated with declines in deer condition and productivity (Leach 1956, Gilbert et al. 1970, Gill 1972, Hall[9] 1973, Wallmo et al. 1977). During a severe winter, net productivity is influenced not only by deer lost to starvation, but also by the poor condition of surviving females, a situation that results in high postnatal fawn losses (Robinette 1976).

The preponderance of males produced by ES and TL deer sampled in 1994 may be the result of small sample sizes that can result in unusual sex ratios (Thomas et al. 1989). Although Robinette et al. (1957) found that mule deer on poor range produced more male fawns, my results do not suggest a male-biased sex ratio in the nutritionally stressed WW mule deer herd.

Reproductive potential in the WW deer herd during 1993 and 1994 was comparable to that reported for other nutritionally stressed mule deer populations throughout the western United States (Anderson et al. 1972, Kucera[1] 1988). This low productivity was likely in response to drought-induced changes in habitat quality, which was compounded by severe winter conditions in 1992-93. During periods of drought, the first step managers should take to maintain deer herd productivity is to increase the quality of the food supply. Therefore, I recommend management practices on WW herd winter ranges and holding areas that promote and ensure access to late season growth of succulent forage on irrigated pasture. Garrott et al. (1987) found that mule deer in northwest Colorado made extensive use of agricultural meadows during autumn; such areas provided deer with succulent forage at a time when the nutritional quality of summer and winter range vegetation was declining because of plant senescence. Hence, Garrott et al. (1987) recommended irrigation and fertilization programs designed to retain succulent forage late into the growing season and restrictions on livestock grazing to avoid competition during periods of heavy deer use. Similar pasture management on WW herd winter ranges and holding areas might enhance deer productivity by sustaining animal condition during periods of drought.

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[9] Hall, W.K. 1973. Natality and mortality of white-tailed deer in Camp Wainwright, Alberta. M.S. Thesis, University of Calgary, Alberta, Canada.

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SOUTHERN RANGE EXTENSION OF THE HARLEQUIN ROCKFISH, *SEBASTES VARIEGATUS* (SCORPAENIDAE)

JAMES WILDER ORR[1] and DAVID C. BAKER[2]
[1]Resource Assessment and Conservation Engineering Division
and
[2]Resource Ecology and Fisheries Management Division
Alaska Fisheries Science Center
National Marine Fisheries Service, NOAA
7600 Sand Point Way NE, Bldg. 4, BIN C15700
Seattle, Washington 98115-0070

We provide two new southern records of the harlequin rockfish, *Sebastes variegatus* Quast, 1971, that significantly extend the known southern distribution of the species. Our southernmost specimen (Fig. 1), a 253-mm standard length (SL) female, was collected by a National Marine Fisheries Service (NMFS) Fisheries Observer during commercial benthic trawling operations 95 km southwest of Newport, Oregon (44°32'N, 124°39'W), over 60 m bottom depth, on 13 September 1994. The second specimen was taken in a benthic otter trawl during the 1995 NMFS triennial survey conducted off the Washington and Oregon coasts. This 223-mm SL female (Fig. 1) was captured on 2 August 1995 off La Push, Washington (47°55'N,

Figure 1. *Sebastes variegatus*: (top) UW 22032, female, 253 mm SL, lat. 44°32'N, long. 124°39'W; (bottom) UW 027978, female, 223 mm SL, lat. 47°55'N long. 125°15'W, off La Push, Washington.

125°15'W), over 226 m bottom depth. Both Oregon (UW 22032) and Washington (UW 027978) specimens are deposited at the University of Washington Fish Collection at the School of Fisheries.

Both specimens agree closely with Quast's (1971) original description. In life, each was reddish (light yellow in preservation) with an entirely black spinous dorsal fin membrane and with prominent dark dorsal blotches that extended across the lateral line. The posterior two-thirds of the lateral line was highlighted in a broad pink-gray zone (light yellow in preservation) that interrupted the posterior dorsal blotches. In life and preservation, the anterior dorsal blotches are uninterrupted by the lateral line, which blends in with the background coloration. The specimens also possess the following counts and characters (abbreviations and methods follow Hubbs and Lagler, 1958): D XIII, 14; A III, 7; P_1 18; pored lateral line scales, 48 (Oregon specimen), 44 (Washington); gill rakers on first arch, 14+27=41 (Oregon) and 13+27=40 (Washington); second anal spine robust and longer than third anal spine; nasal, preocular, postocular, tympanic, and parietal head spines strong; interorbital space flat; symphyseal knob moderate.

Sebastes variegatus may be confused with *S. zacentrus* (Quast 1971, Hart 1973, Eschmeyer et al. 1983, Kramer and O'Connell[3] 1986, Gillespie and Saunders 1994), which is commonly collected along the Pacific coast from the Aleutian Islands to central California and ranges to San Diego (Allen and Smith 1988). Both species are reddish rockfishes with large dorsal blotches that extend ventrally from the dorsal fin to below the lateral line, and both possess the same complement of strong head spines and a prominent second anal spine that is longer and more robust than the third anal spine.

Several characters listed in the diagnosis of Quast (1971) distinguish *S. variegatus* from *S. zacentrus*: lateral line coloration, spinous dorsal fin coloration, pectoral fin ray count, and body depth. In *S. zacentrus*, unlike *S. variegatus*, the lateral line typically blends into the intersecting dorsal blotches (occasionally, the lateral line is somewhat lighter along its entire length). In *S. zacentrus*, the spinous dorsal fin membrane may have dark areas throughout the fin, typically as continuations of dorsal blotches from the body, and may have dark coloration at the tips of the dorsal spines. *Sebastes variegatus* is the only reddish rockfish found in the Northeast Pacific with the membrane of the spinous dorsal fin nearly entirely black. The pectoral fin ray count is typically 18 in *S. variegatus* (as it is in the new material), while in *S. zacentrus* the count is typically 17 (Chen 1986). Consistent with this description, in 13 specimens of *S. zacentrus* collected with the Washington specimen of *S. variegatus*, the count was 17; in one, the count was 16. The body is more slender in *S. variegatus* than *S. zacentrus*, as demonstrated also in the new material (Fig. 2).

Our Oregon record extends the verified southern range by over 500 km. Previously, the southernmost distribution had been reported as Vancouver Island,

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[3] Kramer, D.E. and V.M. O'Connell. 1986. Guide to northeast Pacific rockfishes genera *Sebastes* and *Sebastolobus*. Marine Advisory Bulletin 25, University of Alaska, Fairbanks, Alaska, USA.

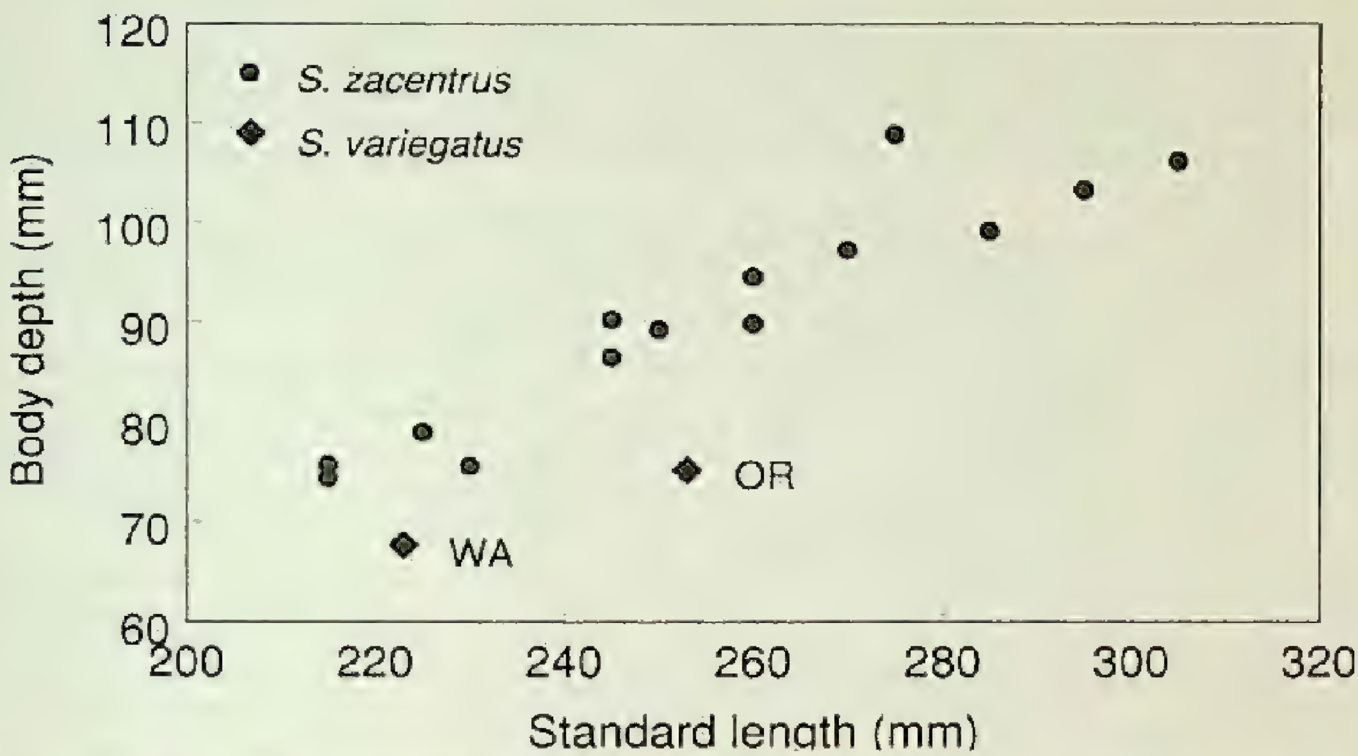

Figure 2. Body depth, measured from dorsal fin base to pectoral fin base, versus standard length in *Sebastes zacentrus* and *S. variegatus*. WA = Washington specimen of *S. variegatus*; OR = Oregon specimen of *S. variegatus*. All specimens of *S. zacentrus* (UW 028214) examined were obtained in the August 1995 haul off La Push, Washington that also contained the 223-mm *S. variegatus*.

British Columbia (Gillespie and Saunders 1994). Allen and Smith (1988) indicated that earlier records in the NMFS database (specimens captured in 1977) from Cape Flattery, Washington, and Bodega Bay, California, were questionable. The later distribution list of adult *Sebastes* of Matarese et al. (1989: Table 29) prepared with the assistance of J. Allen (A. Matarese, NMFS, Alaska Fisheries Science Center, Seattle, Washington, pers. comm.) lists *S. variegatus* ranging south only to British Columbia. Although our new records support the validity of the Cape Flattery record, no specimens were found to support the Bodega Bay record and it must remain suspect. The original field record indicates a single adult identified as "variegatus?" among a large collection of other *Sebastes*, including *S. diploproa* (62 specimens), *S. crameri* (one specimen), and *S. babcocki* (one specimen).

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DISTRIBUTION OF NESTING GREATER SANDHILL CRANES IN THE SOUTH FORK PIT RIVER VALLEY, MODOC COUNTY, CALIFORNIA

THOMAS A. ROBERTS
Environmental Science Associates
301 Brannan Street, Suite 200
San Francisco, California 94107-1849

REBECCA CULL
KEA Environmental, Inc.
455 University Avenue, Suite 370
Sacramento, California 95825

ANNE FLANNERY
Ibis Environmental Services
340 Coleman Drive
San Rafael, California 94901

The greater sandhill crane, *Grus canadensis tabida*, is a threatened species in California. Its low population is the result of habitat loss and disturbance in wintering areas in the Central Valley, summer cattle grazing in nesting areas in northeastern California (Braun et al. 1978), and high predation rates on eggs and unfledged young. Populations probably reached a low in the 1940s (Walkinshaw 1949); numbers have increased since then.

We conducted extensive sandhill crane nesting surveys in Modoc and Lassen counties in 1994 pursuant to environmental impact assessment for a major natural gas pipeline. Our survey effort included many of the areas previously surveyed in 1971, 1981, and 1988 (Littlefield[1] 1982, Littlefield[2] 1989). As these earlier surveys have not been replicated, we report on the part of our survey that revisited the area that Littlefield covered in the South Fork Pit River Valley. The valley is a 19-km-long, 3.2-km-wide area of mostly irrigated meadows and pastures between Highway 395 and the Westside Canal, near the town of Likely in Modoc County. The area is roughly bounded by Signal Butte on the north and by the Lassen County line on the south. This was one of the more productive areas studied by Littlefield, with 12.5% of the state's total observed greater sandhill crane nesting population in 1971 (N=112), 4.7% in 1981 (N=191), and 4.3% in 1988 (N=277).

[1] Littlefield, C.D. 1982. The status and distribution of greater sandhill cranes in California, 1981. California Department of Fish and Game, Wildlife Management Branch Administrative Report 82-1, Sacramento, California, USA.

[2] Littlefield, C.D. 1989. Status of greater sandhill crane breeding populations in California, 1988. California Department of Fish and Game, Wildlife Management Division, Nongame Bird and Mammal Section, Sacramento, California, USA.

We conducted preliminary ground surveys during 10-25 April 1994 to map locations of solitary birds and pairs as they began to occupy territories at the beginning of the nesting season. After consulting with C.D. Littlefield, we performed two helicopter surveys on 9 May and 3 June 1994. We flew at an altitude of 45-60 m – low enough to count individuals but not, in general, low enough to cause birds to flush. Average ground speed was 56-64 km/h, in a meandering pattern approximately 0.8 km on either side of the pipeline right-of-way (ROW) centerline, which in this area was approximately 0.4 km west of, and parallel to, Highway 395. Lateral visibility from our flight altitude gave us an effective search corridor (within which nests could clearly be seen) 1.6 km on either side of the ROW. Follow-up ground surveys confirmed numbers and locations of nesting pairs and enabled us to census all the areas of the valley where Littlefield surveyed in 1981 and 1988.

The total number of nesting pairs of greater sandhill cranes in the South Fork Pit River Valley appears to have been stable over the 24 years from 1971 to 1994, varying between 9 in 1981 and 14 in 1971 (Table 1), with a mean of 11.5 (SD = 2.08). In Littlefield's and our surveys, observers attempted a complete count of all nesting pairs in a flat, open, well-defined area, so we assume the results represent complete censuses.

Nesting use in recent years may have shifted to the northern end of the South Fork Pit River Valley (Fig. 1), possibly in response to changing land use or irrigation patterns. We documented three nests in flooded wild rice fields in the northern portion of the study area and noted that previously documented nest sites in the southern portion are heavily grazed. Another cause may be drought in the early 1990s, which reduced cover and increased predation in the southern part of the area.

Annual counts of greater sandhill crane nests in this area also are available from aerial surveys conducted by the California Department of Fish and Game (CDFG) between 1972 and 1978 (Table 1). These data are less rigorous than those previously presented because crane observations were recorded incidental to waterfowl censuses, which involved other areas between Alturas and Likely. Although the CDFG-recorded

Table 1. Nesting pairs of greater sandhill cranes in southern Modoc County, California, 1971-1994.

Year	Complete counts, South Fork Pit River Valley	CDFG aerial surveys, Alturas to Likely
1971	14	
1972		12
1973		9
1974		3
1975		11
1976		8
1977		10
1978		7
1981	9	
1988	12	
1994	11	
Mean (SD)	11.5 (2.08)	8.5 (2.99)

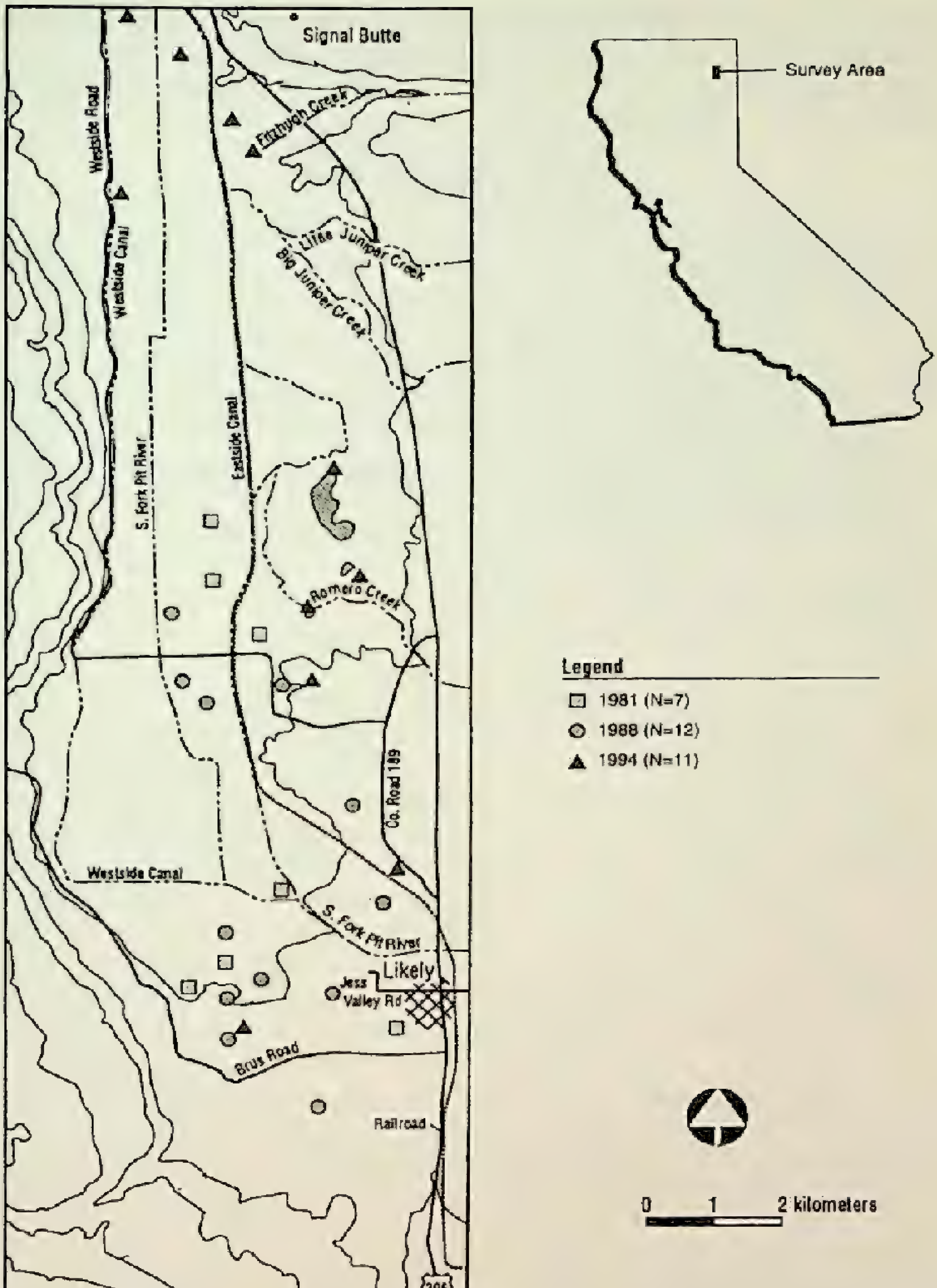

Figure 1. Greater sandhill crane nesting pair locations in 1981, 1988, and 1994, South Fork Pit River Valley, Modoc County, California. Two nest sites recorded by Littlefield in 1981 are not included because they are >3.2 km to the west of the 1994 survey corridor.

nests are probably from the same valley, the survey results are not strictly comparable. However, CDFG counts support the hypothesis of a relatively stable breeding population, varying between 3 in 1974 and 12 in 1972, with a mean of 8.5 (SD = 2.99) and no trend ($F = 0.22$, $P = 0.66$).

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A RED ABALONE TAG RETURN AFTER 16 YEARS AT LIBERTY

IAN K. TANIGUCHI and PETER L. HAAKER
California Department of Fish and Game
330 Golden Shore, Suite 50
Long Beach, California 90802

A tagged red abalone, *Haliotis rufescens*, shell was given to California Fish and Game marine biologists on 26 July 1995 by R. Gutierrez, an abalone processor at the San Pedro Fish-Santa Barbara Station processing plant in Santa Barbara, California. The exact date and location of collection could not be determined because the shell was recovered from a pile of shells that represented several loads of abalone. The date of collection can only be narrowed to the week of 23-29 July 1995.

This abalone was tagged originally on 10 July 1979 at Johnson's Lee on the south side of Santa Rosa Island (33°54'N,120°06'19"W) during a multi-year tag-recapture growth study, but it was not observed during any of the following surveys (1980-84). When tagged, it measured 147 mm long and 113 mm wide. The recovered shell measures 198 mm by 165 mm, increases of 51 mm and 52 mm over 16 yr. This growth closely fits the Von Bertalanffy growth curve for 1979-82 (Haaker et. al.,[1] in prep.) (Fig. 1).

The tag used on this abalone was a 15-mm square piece of stainless steel sheet metal with alpha-numeric characters stamped on it and a hole in one end. A length of stainless steel wire (Type: 302/304, Condition: A, Diameter: 0.8128 mm) was threaded through the hole and wrapped back around itself, leaving a wire tail (Haaker et al.[2] 1986). The tag was attached by passing the wire through the two most anterior completely formed respiratory pores, wrapping it back around itself several times at the base of the tag, and trimming the excess wire. The recovered tag was in good shape, with little encrustation (Fig. 2). The two respiratory pores through which the tag was threaded were sealed from the inside by the shell layers, but the external pores were incompletely filled with shell material because of the wires. Six additional respiratory pores anterior to the tagged pores were formed after tagging; two of these were closed and four were open.

When this abalone was tagged, no sign of the boring sponge, *Cliona celata californiana*, was noted on the shell. Moderate to heavy infestation of *Cliona* is now apparent on older portions of the recovered shell. *Cliona* is a yellow boring sponge that is often found living commensally on mollusks and cirripeds. The sponge

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[1] Haaker, P.L., D.O. Parker, and K.C. Barsky. In Preparation. Growth of red abalone, *Haliotis rufescens*, at Johnson's Lee, Santa Rosa Island, California. California Department of Fish and Game, Marine Resources Division, Long Beach, California, USA.

[2] Haaker, P.L., D.O. Parker, and K.C. Henderson. 1986. Red abalone size data from Johnson's Lee, Santa Rosa Island, collected from 1978 to 1984. California Department of Fish and Game, Marine Resources Technical Report No. 53.

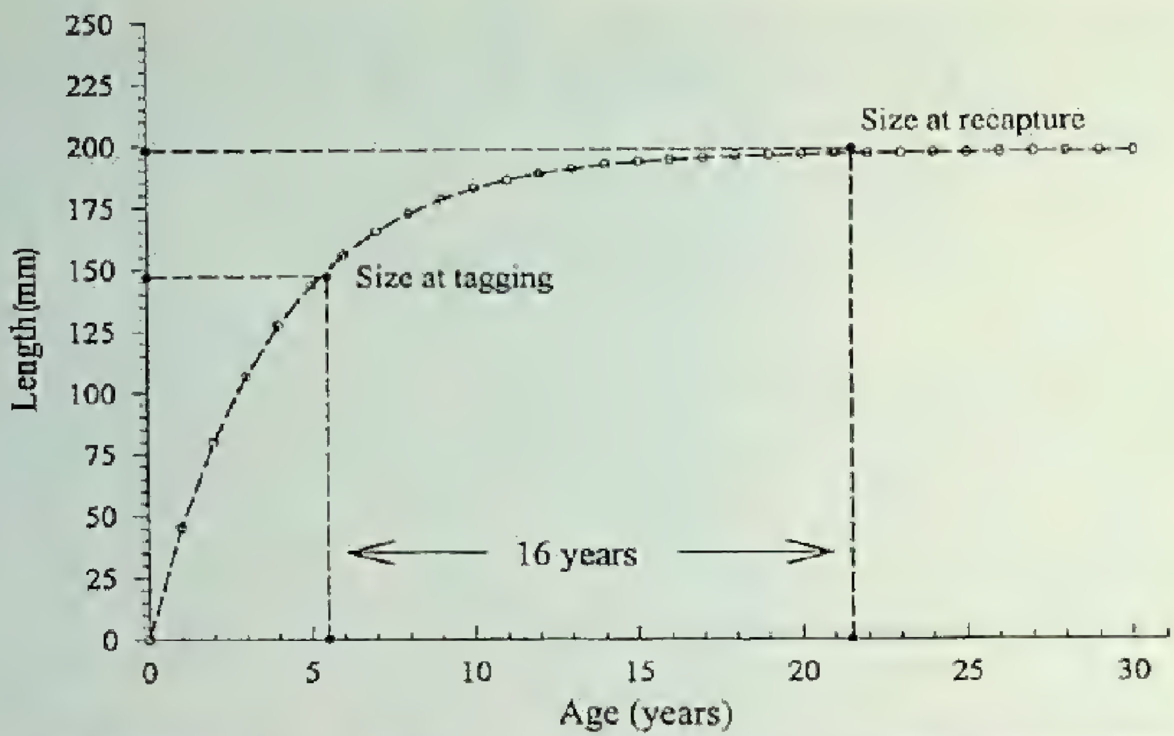

Figure 1. The Von Bertalanffy growth curve generated from the tag-recapture growth data for 1979-1982 (n=657) at Johnson's Lee, Santa Rosa Island, California (Haaker et al.,[1] in prep.)

Figure 2. Tagged red abalone shell recovered after 16 yr at large. A. Ventral view of the inside of the shell. Ruler length is 152 mm. B. Dorsal view with the tag showing in the upper left portion of the shell. C. Close-up view of the tag.

anchors itself by drilling a network of holes into the shell of its host (MacGinitie and MacGinitie 1949). *Cliona* infestation can cause structural weakening of the shell (Hansen 1970) and a heavy infestation may retard normal growth by causing the abalone to secrete additional nacre on the inside portions of the shell to repair the boring sponge damage (Ault 1985, Haaker et al.[2] 1986).

The recovery of this red abalone 16 yr after it was tagged represents the longest known period of tag retention for any abalone species. The condition of the stainless steel tag and its attachment wire is evidence that this tag type is durable and persistent.

More recently, abalone tagging studies have employed number-stamped stainless steel washers, similarly attached with wires. This simplifies the manufacture of tags, as standard washers may be used, thus eliminating the time-consuming process of

cutting sheet stainless steel. The use of washers also eliminates the possibility of injury to the abalone, as well as the person tagging, by the sharp-cornered square tags.

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FIRST FRESHWATER RECORD OF PACIFIC LAMPREY, *LAMPETRA TRIDENTATA*, FROM BAJA CALIFORNIA, MEXICO

GORGONIO RUIZ-CAMPOS and SALVADOR GONZALEZ-GUZMAN
Laboratorio de Vertebrados, Facultad de Ciencias
Universidad Autonoma de Baja California
Apdo. Postal 1653
Ensenada, Baja California 22800, Mexico
U.S. mailing address: P.O. Box 189003-064
Coronado, California 92178

An ammocoete of the Pacific lamprey, *Lampetra tridentata*, was collected on 19 February 1995 in the lower Rio Santo Domingo, Baja California, Mexico, approximately 600 m above its mouth at Bahia San Ramon, 6 km west of Vicente Guerrero (30°43'N, 116°02'W; Fig. 1). This species had not been previously reported from freshwater in Baja California (Follett 1960, Castro-Aguirre1978, Ruiz-Campos and Contreras-Balderas 1987, Page and Burr 1991). The previous southernmost known freshwater record for this species is the Santa Ana River in southern California (Jordan and Evermann 1896, Swift et al. 1993).

The Pacific lamprey is an anadromous species distributed from Hokkaido, Japan, through the Bering Sea and Aleutian Islands (Hart 1973) to Punta Canoas, Baja California, Mexico (Hubbs 1967, Miller and Lea 1972). This species commonly spawns in the rivers of western North America from Alaska to southern California (Hubbs and Potter 1971). In southern California, this species still maintains runs in several unaltered creeks from the Carmel River south to the SantaAna River (Swift et al. 1993). Its habitat requirements and distribution are similar to those of the anadromous rainbow trout, *Oncorhynchus mykiss*, in southern California (Swift et al. 1993). The ammocoete lacks a sucker and lives buried in the mud, feeding on micro-organisms for about 5 yr. After metamorphosis, the young adult (about 135 mm total length [TL]) migrates downstream to the sea (Hardisty and Potter 1971).

Hubbs (1967) recorded the first marine occurrence of Pacific lamprey in Baja California, 55 km southwest ofPunta Canoas (28°58'N, 115°25'W). Thespecimen, a juvenile male 170 mm TL, was captured during a pelagic research trawl along with Pacific hake, *Merluccius productus*. Hubbs(1967:304) speculated that the juvenile lamprey "hitch-hiked a ride on a hake" from "one of the streams tributary to Monterey Bay, central California, the southernmost streams in which any massive spawning of the species has been recorded." Our specimen of Pacific lamprey from the lower Rio Santo Domingo represents the southernmost freshwater record of this species in western North America.

The specimen was captured with a minnow seine at a branch in the stream, 5 m wide, 40 cm deep, bottom of sand and gravel, and salinity 0.3 ppt, flowing into a lagoon near the mouth of Rio Santo Domingo. The ammocoete (126.5 mm TL, 3.0 g) was preserved in 10% formalin and identified by the following diagnostic

Figure 1. Map showing the geographical location of the mouth of Río Santo Domingo, Baja California, Mexico.

characteristics (Hubbs 1967, Hart 1973, Page and Burr 1991): hood surrounding toothless mouth, nasal pit, confluent gill openings, and body brown on sides and back and light silver below. Measurements (proportions of TL) and counts of the specimen are as follows: tail length, 0.289; body depth, 0.058; branchial length, 0.111; height of first dorsal (with fleshy base), 0.006; height of second dorsal (with fleshy base), 0.014; length of first dorsal, 0.153; and number of trunk myomeres, 67.

The specimen (UABC-0111) is deposited in the Fish Collection, Facultad de Ciencias, Universidad Autonoma de Baja California, at Ensenada, Baja California, Mexico.

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PAST OCCURRENCE OF EULACHON, *THALEICHTHYS PACIFICUS*, IN STREAMS TRIBUTARY TO HUMBOLDT BAY, CALIFORNIA

MARK R. JENNINGS[1]
Department of Fisheries
School of Natural Resources
Humboldt State University
Arcata, California 95521-9905

The substantial decline of eulachon, *Thaleichthys pacificus*, in northern California over the past two decades has stimulated efforts to document past occurrences of this fish at the southern edge of its range (Moyle et al.[2] 1995). The most southern spawning run of eulachon was in the Mad River, Humboldt County, California (Odemar 1964). South of this drainage, eulachon have occasionally been found during the winter in Humboldt Bay (Barnhart et al. 1992), but there are no reports of adults in tributary streams. I present evidence that, in the recent past, eulachon spawned in streams tributary to Humboldt Bay.

On 10 May 1977, I found a dead, spawned-out, male eulachon (211 mm total length [TL]) on the screen of a McBane downstream migrant trap located on Jolly Giant Creek, a small stream that flows into Humboldt Bay approximately 7 km south of the Mad River. Four days later, Mr. W.G. Harper collected a second male eulachon (212 mm TL, 53 g) in spawning colors from a McBane trap on Jacoby Creek, 1.5 km south of Jolly Giant Creek. Both specimens were identified by R.A. Behrstock (formerly of Humboldt State University) who reported six other adult eulachon observed by Harper in the same McBane trap on Jacoby Creek (R.A. Behrstock, pers. comm.).

Previous records of eulachon in Humboldt Bay are rare (Emmett et al. 1991). Gotshall et al. (1980:229) reported this species as an "occasional visitor" and Samuelson[3] (1973) collected one adult from South Bay on 23 April 1970. Larval stages of this fish are poorly described (Young[4] 1984) and this may contribute to the lack of historical larval collections in the bay (e.g., see Eldridge and Bryan 1972).

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[1] Current address: National Biological Service, California Science Center, Piedras Blancas Field Station, P.O. Box 70, San Simeon, California 93452-0070.

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Three other osmerids, *Hypomesus pretiosus*, *Spirinchus starksi*, and *S. thaleichthys*, are relatively common in Humboldt Bay and their larvae have been frequently noted during past surveys (DeGeorges[5] 1972, Emmett et al. 1991, Barnhart et al. 1992).

Spawning of eulachon in streams tributary to Humboldt Bay may be natural or the result of straying from large populations in the Mad River during the early to mid-1970s (see the accounts in Moyle et al.[2] 1995). Until about 2,000 years ago, the Mad River flowed into Humboldt Bay (Vick[6] 1988) and, as recently as the 1850s, a canal connected the Mad River to Arcata Bay (Coy 1929). Such activities may have allowed the straying of eulachon into Humboldt Bay streams to produce intermittent spawning runs.

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